

**TEXTBOOK OF  
GENITO-URINARY SURGERY**

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# TEXTBOOK OF GENITO-URINARY SURGERY

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HYDRONEPHROSIS, DISTURBANCES OF MICTURITION AND VARIATIONS IN THE AMOUNT OF URINE EXCRETED, A SIMPLE TECHNIQUE FOR FULGURATION OF BLADDER PAPILLOMATA, FOREIGN BODIES IN THE BLADDER, THE FEMALE URETHRA, PERINEAL PROSTATECTOMY; COMMENTARY ON THE VARIOUS SURGICAL PROCEDURES FOR THE RELIEF OF PROSTATIC OBSTRUCTION, CYSTITIS PERICYSTITIS INFECTIONS OF THE KIDNEYS AND URETERS, URINARY FEVER, LEUCOPLAKIA AND MALACOPLAKIA OF THE URINARY TRACT, GENERAL FEATURES OF CALCULOUS DISEASES OF THE URINARY TRACT, CALCULOUS DISEASE OF THE BLADDER, URETHRAL CALCULI PREPUTIAL CALCULI

## PREFACE

THE need for an up to date work by British Urologists has been apparent for a considerable time and when the Publishers approached me on this matter I fully agreed that such a book was highly desirable and this end has been served by a well chosen team of authors. In fact it would be right to say that only because of the harmonious and whole hearted co operation of this team has it been possible to produce a tome of the size and importance of this volume.

The work covers the urinary tract and the male genital system from the surgical point of view. Such controversial subjects as the different methods of removing prostatic obstruction are fully discussed.

Post war conditions have made the task of publishing serious works a formidable undertaking. To add to these difficulties after the type for this work had been all set up the publishers suffered a fire at their printing works which destroyed it all. The delay caused by such a catastrophe to a busy publishing firm can be fully appreciated when it is realized that the type was lost of about thirty other books which were also in the course of printing. A postponement in bringing out this work in the circumstances was inevitable. We congratulate the publishers on their speedy recovery. As a consolation the delay provided the opportunity of bringing the work up to date and no pains have been spared to accomplish this end.

My sincerest thanks go out to the individual authors for the essential part they have played in making the task of editing this volume worth while.

Finally my gratitude is extended to the *British Journal of Urology* for the use of blocks from which many of the illustrations are reproduced.

There seems no prospect of a universal adoption of any one of the standards of measurement for urethral instruments. This point is well exemplified by the different tastes exhibited by the authors who have contributed to this work and I have made no attempt to interfere in this matter.

In American literature almost universally and in our own to a slightly less extent the Charrière scale is referred to by the letter F (French). It would seem that usage will have its way on this point. On the other hand the Association Française d'Urologie in 1926 decided to graduate all bougies and catheters according to a new scale which they called Béniqué. The difference between the old and the new being that in the former there was a difference of a third of a millimetre between adjacent sizes and in the latter a sixth of a millimetre. This change has resulted in French made instruments being marked in both systems so that the Béniqué marking gives a number which is twice that of the Charrière.

This finer grading undoubtedly shows a proper regard for the delicacy of the urethral mucous membrane. It also calls attention to the coarse and unsatisfactory grading of the instruments marked in the English scale. Another advance would undoubtedly be to persuade the British makers to follow the French system.

H P WINSBURY WHITE

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## CHAPTER I

### THE APPLIED ANATOMY OF THE KIDNEYS AND URETERS

**T**HE kidneys are paired organs and each is provided with a duct known as the ureter. The kidney and ureter on each side lie behind the peritoneum and extend from the upper part of the abdominal cavity to the lower part of the pelvic cavity. Each kidney weighs 4oz and measures in length 4½ in and in width 2½ in and in thickness 1½ in. The ureter is 12 in long and ¼ in in external diameter whilst its lumen is about ⅙ in across. Any deviation from the normal should be viewed with suspicion by the surgeon. Important relations of the kidney and ureter are not very commonly seen when the surgeon is operating upon these parts. It is in difficult operations that the surgeon finds their importance. The structures which are most commonly noted are the ascending colon and the descending colon as well as the liver and the peritoneum but in difficult cases the position of the splenic and the inferior mesenteric vessels should be known as well as the subperitoneal plexus of Turner which in certain cases may be enormously enlarged. It is in pathological conditions that a knowledge of anatomy is particularly useful. The kidney in addition to excreting urine has some of the functions of an internal secretory gland as is shown in renal rickets and dwarfism.

**Bony structures in relation to the kidneys and ureters**—The topography of the parts in relation to the kidney and ureter may be arranged from within out, and the bony markings will first be described. These are the costal margins and the lower part of the thorax the lowest dorsal and all the lumbar and sacral vertebrae and the ossa innominata. The line of the costal margin forms an angle of 90° with its fellow varying from 70° to 110° but is separated from it by the lower part of the sternum. The costal margin is formed as a rule by the lower six ribs and their cartilages. The twelfth rib passes athwart the kidney about its middle and the eleventh rib passes downwards and outwards in relation to the upper pole of the kidney. The intervals which lie between the last three ribs are wider than those between the other ribs and the last two ribs are inclined downwards more than the others.

The costal margin is variable both in front and behind and there may be only eleven ribs or there may be thirteen. The twelfth rib varies in length and may be asymmetrical with its fellow. The costal margin runs along the last rib and crosses the eleventh and then reaches the tenth rib the costal cartilage of which joins the ninth which joins the eighth and thus again joins the seventh which articulates with the lower part of the body of the sternum. Eight ribs however may join the sternum or only six may do so. Examination of these features should always be made before any further examination or operation is done. In front the costal margin lies anterior to each kidney and only three fifths of each kidney lies under cover of its appropriate margin.

The lumbar vertebrae must never be considered without their intervertebral discs which form about two fifths of the total length of this part of the spinal column. The lumbar vertebrae five in number occupy more than half the length of the dorsal vertebrae which are twelve in number. The most prominent portion of the lumbar part of the spinal column lies opposite the

but in case they do not meet, then a triangle is left between the two adjacent edges of these muscles and the crest of the ilium, which is known as the "triangle of Petit." The floor of the triangle is formed by the fibres of the "internal oblique."

Another triangle is found deep to the "latissimus dorsi," of which the base is directed upwards and is formed by the twelfth rib, and the edges are formed by the "internal oblique" and the "erector spinæ," and the floor is formed by the aponeurosis of the "transversalis" muscle (Stiles). The floors and edges of these two triangles indicate how the external and internal oblique muscles and the transversalis muscle lie in order from within outwards the last muscle being the deepest and the external oblique the most superficial.

The great mass of the "erector spinæ" as a surface marking is chiefly used for filling up the deep furrow on either side of the spine, and forms a very definite ridge in muscular subjects. Its outer edge crosses the last rib about its middle and at this point the lumbar nephrotomy wound is commenced. Two more muscles must be mentioned, namely the "serratus posticus inferior" and the "pyramidalis." The former lies under the "latissimus dorsi," and its fibres are directed transversely between the spines of the lower dorsal and upper lumbar vertebrae and the four last ribs. The lower edge of this muscle is divided in lumbar nephrotomy.

The "pyramidalis" lies above the pubes, is paired and each portion lies above the body of the pubes from which it is directed upwards and inwards to reach the linea alba, it is only about 2 in. long but is of use to the surgeon as it indicates the middle line of the body during operations in its neighbourhood, such as that of suprapubic cystotomy.

**The cutaneous surface markings**—These are developmental in origin or they are acquired. To the former class belongs a pigmented vertical line which passes from the umbilicus to the pubes and passes thence over the skin of the penis and the scrotum to the perineum, ending within the anal margin where it ends in a small tubercle. It is of value to the surgeon as indicating the middle line in these regions.

Other such markings are due to the comparatively rare formation of accessory nipples or mammae. When present these run on a line from the axilla to the pubic region. The line corresponds to the mammary line of some of the lower animals. They are more common in the thorax than the abdomen. They may actually form in line with the genital eminence, which forms the penis or clitoris, and this may explain why some psychologists see a resemblance in shape between the penis and the mamma.

The acquired surface markings are developed in parous women and lie transversely or circumferentially on the front surface of the abdomen. They are known as "lineæ atrophicæ" and are usually white and flush with the abdominal surface. Very different is a line which is developed in the lower part of the abdomen *part passu* with the formation of fat in the abdomen of elderly people. This line lies parallel with and above the groins and is continuous across the middle line. It may be very deep and foul and its presence may lead to gaping of a wound across its course, e.g. that of suprapubic cystotomy.

**The surface markings of the kidney and ureter**—The kidney may be marked out from behind by the method of Morris. A line is drawn parallel with and 1 in. from the spines of the vertebrae from the twelfth dorsal to the third lumbar. From the upper and lower levels of this line a transverse line is drawn outwards for  $2\frac{1}{2}$  in. A fourth line joins their outer ends. A parallelogram is thus completed in which the kidney lies. In the front the kidney may be marked out

as follows. A line is drawn from the junction of the bone and cartilage of the fifth rib to the junction of the mesosternum and xiphisternum. The lowest part of the costal margin is taken and on this point and line a parallelogram is raised. Within the lower three quarters of this parallelogram the kidney lies. It is of special value in the examination by X-rays, and it shows well how relatively high the kidney is.

Or the position of the kidney may be obtained thus. Draw a transverse line through the umbilicus and select a point  $2\frac{1}{2}$  in from the middle line. Select further points on the right side 1 in and on the left side  $1\frac{1}{2}$  in above the first line. From this point on either side draw a line upwards and sloping slightly inwards for  $4\frac{1}{2}$  in so that the upper part of the line is 2 in away from the mid line. This line indicates on each side the position and slope of the kidneys.

To obtain the surface markings of the ureter a complicated method is needed. A line is drawn between the anterior superior spine of the ilium and the symphysis pubis. From the middle of this line another is drawn to a point  $\frac{1}{2}$  in above and  $\frac{1}{2}$  in to the left of the umbilicus. This point indicates the position of the bifurcation of the aorta, and the line indicates the course of the common and external iliac vessels. At the junction of the upper and middle thirds of this line the ureter crosses the bifurcation of the common iliac artery. A line raised from this point to the inner edge of the kidney will indicate the position of the abdominal ureter. Its pelvic position is indicated by a line drawn downwards and inwards from the bifurcation of the common iliac artery to just above the body of the pubes  $\frac{1}{2}$  in external to the symphysis pubis.

There are two objections to the surface markings which were introduced by Cunningham and have received general acceptance. First the umbilicus does not always lie in the zone which received its name, and it would seem that the term "hypogastric" is rather a feeble one for a zone which contains the bladder, "that which lies below the stomach" cannot have much appeal to urologists. "Suprapubic" would be more accurate and less confusing.

With regard to the first point it may be stated that the umbilicus may lie as much as 2 in above the intertubercular plane, or at the level of this plane or as much as 1 in below it. Now this is rather a serious margin of error for such an important and generally recognized level, but the followers of Cunningham will remember that if the umbilicus itself does not lie in the zone to which it gives its name yet the obliterated umbilical vein does so lie, and for this reason the name may suitably be retained.

The position of the umbilicus bears no apparent relation to the height of the individual or to the length of the space between the subcostal and the intertubercular planes and the only sexual characteristic appears to be that the level of the umbilicus seems to vary more in females than in males. That the umbilicus may to such a large extent vary as to its level, and that the sexual prominence may not be as obvious as its description would imply, will make a clinical examiner or an operating surgeon rather careful to remember these difficulties.

The immediate relations of the kidneys and ureters—The structures which lie in relation to the kidneys are as follows. The peritoneum and the ascending and descending parts of the colon are most commonly seen at an operation and the liver may be felt especially when Riedel's lobe is present but if the naked liver is seen it means that the peritoneal cavity has been opened. The author has not seen any other structure at an ordinary renal operation except on one occasion the duodenum and on very few occasions the inferior vena cava. He has seen once only the aorta and the position of this was indicated by the tissue paper like appearance of its superficial coats nor has he seen the pancreas nor the splenic or the inferior mesenteric vessels.

Curiously enough the writer has never seen either normal adrenal body at a renal operation. It would appear that the living connective tissue found between the adrenal and kidney is wider than that found in the preserved bodies of the dissecting room. It is in neoplastic conditions of the kidneys that their anatomical relations should be known. The shape of the kidney is so well recognized that it has been taken as a standard description of shape.

The kidneys are situated farther from the middle line than is commonly realized and the right kidney is usually felt at the level of the tenth costal cartilage farther out than the left. The kidneys like other solid organs of the abdomen lie in the upper part of the cavity, and this part owing to the splay of the lower part of the thorax and the deep paravertebral furrow, is much the most capacious. Each kidney lies in an oblique plane so that its anterior surface looks outwards and forwards and its posterior surface looks inwards and backwards. Each shows a superior and inferior pole an inner concave and an outer convex edge.

Near the middle of the inner edge the hilum is largely responsible for its concavity and through the hilum the vessels and ureter enter or emerge from the kidney. The anterior relations of the kidney vary with the side but the posterior relations are similar on both sides allowance being made for the slightly lower position of the right kidney than that of the left.

**THE RIGHT KIDNEY**—At the extreme upper pole the right adrenal fits like a helmet over the kidney. It does not extend on to the inner edge nor stray much over the surfaces. The liver lies in contact with this kidney over an area which comprises nearly the upper two thirds of its anterior surface whilst in front of the inner edge and the hilum the second part of the duodenum lies. This area varies much in extent. External to and below the hepatic area the hepatic flexure of the colon lies.

There is a cul de sac of peritoneum which intervenes between the liver and the kidney but the membrane which covers the colon and the duodenum may spread out so much that these organs may come into direct relation with the kidney. The gall bladder has no direct relation to the kidney but it lies on a plane in front of the hilum with the hepatic flexure of the colon and the duodenum intervening. The only extrarenal vascular relation is that of the inferior vena cava which runs upwards behind the renal artery and close to the inner edge of the right kidney and adrenal. The foramen of Winslow lies on a plane in front of and to the inner side of the right kidney.

**THE LEFT KIDNEY**—On the left side the relations are as follows. The left adrenal lies more on the inner edge of its kidney than its fellow and fits and looks more like a tilted Glengarry cap than a helmet. The spleen lies in relation to the outer edge and anterior surface in the upper half and the body of the pancreas passes across the lower part of the hilum and the anterior surface of the kidney. In the triangular area between these viscera the stomach lies but the gastric area is quite small. Below the pancreas the splenic flexure

lies against the kidney, and internal to this area the root of the mesentery and the first part of the jejunum lie

*The vascular relations*—These are as follows At the upper edge of the pancreas the tortuous splenic artery is found crossing the kidney on its way to the spleen whilst at some distance below this vessel the splenic vein runs to join the portal vein Both these vessels are in contact with the kidney The superior mesenteric artery and vein are in relation to the front of the inner edge of the lower pole of the left kidney

*Relation of the left kidney to the peritoneum*—Between the stomach and the kidney lies the left portion of the lesser sac, whilst on the outer edge of the kidney the lateral prolongation of the great sac, which comes into relation with the spleen, projects At the level where these two parts of the peritoneum meet, the lienorenal ligament is formed, and it is in this ligament that the splenic artery is found after it has passed across the anterior surface of the kidney The root of the upper part of the mesentery comes into relation with the inner side of the inferior pole, but the peritoneum which forms the descending mesocolon spreads out widely, so that little of the kidney is covered by peritoneum in this region Inside the great sac of the peritoneum the left edge of the great omentum is extended back so as to almost overlap the left kidney

*THE POSTERIOR RELATIONS OF THE KIDNEYS*—These are quite symmetrical and are constituted solely by fasciæ, muscles and nerves Each kidney lies in the angle that is formed by the "psoas" internally and the "quadratus lumborum" externally Both these muscles are covered by strong fasciæ, which are specially developed over their upper parts to form over the "psoas" the internal arcuate ligament, and over the upper part of the "quadratus lumborum" the external arcuate ligament Into these ligaments the diaphragm is, in part, inserted, and this muscle, therefore, comes into relation with the upper part of the posterior surface of each kidney

Each crus of the diaphragm lies to the inner side of the kidney If either crus is seen at an operation it means that the surgeon is in the near proximity of the semilunar ganglion and the aorta The "psoas" lies on the side and front of the vertebral column from the level of the twelfth dorsal to the fifth lumbar vertebra The "quadratus lumborum" lies behind and external to the upper part of the "psoas" The fibres of the "psoas" are directed downwards and outwards, the fibres of the "quadratus lumborum" pass upwards and slightly converge upon the fibres of the "psoas" On the front surface of the "psoas" a small tendon, that of the "psoas minor," is occasionally found It is yellow, bright and glistening, and thus it is distinguished from the ureter, which occupies much the same position and direction

The "psoas" is joined in the lower part of the abdominal cavity by the "iliacus" muscle which runs into its outer edge The "transversalis" muscle is found at the outer edge of the "quadratus lumborum" Its fibres are here directed outwards and it forms here the main portion of the lumbar fascia The aponeurosis of the transversalis splits behind to form the sheath of the "quadratus lumborum," and the anterior part of this sheath again splits to form the sheath of the "psoas" The late Mr Clement Lucas taught that contractions of the "psoas" might influence the kidney symptomologically

*The relation of nerves to the kidneys*—The twelfth dorsal nerve emerges from beneath the external arcuate ligament and is inclined more obliquely downwards and outwards than is the twelfth rib from which it is separated by a considerable interval The twelfth dorsal nerve is met with not only in this region, for it pierces the "transversalis" muscle and then lies deep

to the "internal oblique," and as it passes forwards and downwards it is met with in front, after this muscle has been divided during the operation which approaches the kidney from the lumbar region. The nerve should be avoided as far as possible as it supplies the lower part of the "rectus" muscles as well as the skin of the lower part of the abdominal wall. The iliohypogastric and ilioinguinal nerves lie behind the kidney as well as the small nerves these send to join the lumbar plexus. If the kidney on the right side be lower than usual the external iliacous nerve may be a posterior relation.

To all these nerves many of the symptoms of renal trouble are due. The lowest part of the semilunar ganglion, which is known as the aortic renal ganglion, supplies the main part of the kidney, but branches also pass from the aortic plexus. The former branches pass along the inner edge of the kidney, whilst the latter pass to the hilum with the main vessels. There is a branch of the right vagus which communicates with the right renal sympathetic nerves. The left kidney is not similarly supplied, and it has been suggested that operations upon the right kidney are associated with more shock than operations upon the left kidney by reason of this vagal connection (Marston).

*Relation of kidneys to the pleura*.—The pleural membrane has an important relation to the kidney on each side. The inferior line of pleural reflection is divided into three parts—posterior, anterior and diaphragmatic (Cunningham). It is in connection with the third part that the urologist is particularly interested. Posteriorly the line of reflection passes across the eleventh rib to reach the eleventh intercostal space, and the twelfth rib over its inner half.

When the kidney is situated higher than usual, or when it is fixed to the diaphragm by processes of disease, the diaphragm may be wounded. As the pleura is more intimately adherent normally to the thoracic wall in the region of the diaphragm a wound of the muscle makes a wound of the pleura almost inevitable and this is indicated by a rush of air into the pleural cavity. Consideration of this relation of the pleura to the kidney on each side will also explain why empyema may occur secondarily to an infection of the kidney. When there are only eleven ribs the kidney may be placed at a high level.

The lower margin of the lung is situated at a much higher level than the line of reflection of the pleura, hence there is no likely danger of the lung being wounded when a renal operation is being performed.

*Relations of the lower intercostal arteries and the subcostal artery to the ribs, in the region of the kidney*.—The tenth and eleventh intercostal arteries lie in the appropriate subcostal grooves but the subcostal artery which passes downwards and outwards below the lower edge of the twelfth rib is separated by some distance, about  $\frac{1}{2}$  in from this rib. Thus its position may not be suspected and it may be wounded at a renal operation. The subcostal or twelfth nerve of the series accompanies this artery, and it is always important that this nerve should not be divided at an operation, for the reason already stated.

**THE HILUM OF THE KIDNEY**.—The posterior lip of the hilum normally projects more than the anterior lip, and any deviation from this rule must be viewed with suspicion as to the functional integrity of the kidney. The contents of the hilum are the renal artery, which lies behind the renal vein, and the ureter, which lies behind both the vessels, as well as nerves and lymphatics and connective tissue.

When the vessels are ligatured preparatory to division at an operation, their sloping direction must be noted, otherwise unless the cutting of the pedicle is exactly at right angles to the vessels either they may be wounded or the ligature be cut.



In addition to these structures there are also lymphatic glands and sympathetic nerves. The glands are frequently the starting point of disease, which later invades the kidneys. The main vessels may divide much earlier than is usual. The renal artery gives off the largest adrenal artery, namely, the inferior capsular, and it also supplies the main part of the ureter along which branches from this origin pass as far as the base of the bladder, as becomes evident when careful dissection is made of enlarged and tortuous ureters. An ectopic adrenal or an aberrant spleen may be found in the hilum of one kidney, the spleen being found only on the left side.

The pelvis of the kidney forms usually a single cavity, which is placed well within the substance of the kidney. It is frequently double, and the double pelvis has not as big a capacity as the single normal one, which may explain the symptom of pain which accompanies the condition. From the pelvis the passage proceeds downwards to form the ureter, but the exact level of the junction is not very clearly shown. The shape of the pelvis is well known and may be very briefly described as having three or four bays.

**THE RELATIONS OF THE URETERS.**—The ureter frequently passes down behind the lower pole of its kidney, but it may pass in front of the lower part of the kidney, in which case it should be viewed with some suspicion. After leaving the pelvis the ureter shows a slight arch with its convexity inwards, but it very quickly assumes its normal vertical position on the anterior surface of the "psoas" muscle. It lies behind the peritoneum, but it is much more intimately related to this membrane than it is to the muscle, and when the kidney and ureter are displaced forwards at any operation the ureter is found adherent to the posterior part of the peritoneum and may, for this reason escape notice.

The ureter crosses the bifurcation of the common iliac vessels and is itself overlapped by the iliac mesocolon. Below this it lies in front of the internal iliac artery and crosses the obturator nerve and the inferior vesical artery. It should be noted that in this region it lies very near to the great sciatic notch; it passes inwards and is crossed by the vas deferens.

As it enters the bladder it lies above and in front of the vesicula seminalis. It passes through the bladder wall for at least half an inch with generally a transverse direction but with a downward tendency. It opens at the summit of a small papilla, which is so shaped that the direction of the flow of urine through the orifice is upwards and outwards and the urine impinges upon the bladder wall above and to the outside of the opposite orifice, and this place of impingement is a very common site for the beginning of a papilloma.

In the female pelvis the relations are very different. Any fold of peritoneum in the pelvis must be regarded as a possible covering of the ureter, but its normal course lies on a plane internal to the ovary and deep to the broad ligament. It lies behind the peritoneum and deep to it in the pelvis, and later comes into close relation with the cervix and the upper part of the vagina. Whilst the relations of the ureter in both sexes are quite symmetrical in the pelvis, they are asymmetrical in the abdomen but similar in both sexes.

The right ureter crosses the common iliac vessels more at a right angle on the right side than on the left. Above this in the abdomen the right ureter comes into relation with the duodenum near the hilum, and is crossed lower down by the root of the mesentery. The cæcum lies to the right of this ureter, and may overlap it whilst the appendix may cross in front of it though it has no direct relation to it. It is stated that the lymphatic glands on the right side have a more intimate relation to the right ureter than the corresponding glands on the left side have to the left ureter (Barclay Smith).

The left ureter sometimes comes into relation with the upper part of the mesentery and above this with the pancreas. Lower down it is crossed by the attachment of the iliac mesocolon and may be overlapped by the corresponding portion of bowel if it has fallen over to the mesial position which is frequently the case. These different relations on both sides and in addition the intimate relation that the heavy liver bears to the right kidney may be associated with the possible fact that the right kidney appears to be more liable to disease than the left and that stones are more frequently passed on the left than the right side. Blood too is more liable to clot in the right pelvis than in the left and it may be that there is more obstruction to the passage of urine along the right ureter than along the left.

**THE FASCIAL COVERINGS OF THE KIDNEYS AND URETERS**—The upper urinary organs are covered by loose cellular tissue just as are the bladder and the prostate and other pelvis contents. In the old days of dissection this tissue was frequently found to be affected with disease and thus became much thicker and formed very definite fibrous layers but at the present day this conception has been changed for that which regards such fascial layers as consisting of loose cellular tissue which conveys lymphatics, blood vessels and nerves just before their final distribution.

No doubt there are thickenings of the fascia such as the arcuate ligaments on each side of the middle line and the fascia over the psoas, quadratus lumborum and iliacus muscles can be quite readily made out but the conception of the fascial layers as possible carriers of infective processes to the kidneys is a very important one.

The fascia of the abdominal wall is covered by the fatty retroperitoneal tissue and a very special part of this general layer is that which is known as the perinephric tissue. This makes connection indirectly with the general retroperitoneal tissue and passes up from the pelvis where it lies in relation with the fascia which covers the prostate, bladder and rectum and indeed makes connection posteriorly with the ischio-rectal space.

As this layer is traced up from the pelvis it will be found to form two columns, one on each side of the vertebral column and to pass upwards in connection with the uterus, ovaries and Fallopian tubes in the female eventually forming as it were a process of cellular tissue which covers the ureters and the kidneys on each side of the middle line. These processes are quite distinct on each side from each other. The process on each side terminates between the adrenal and the kidney and separates these structures from each other.

Various fanciful fascial layers have been described varying with the patience of the dissector such as one that is stated to pass through the fascia over the iliacus and then to fade away over this muscle. The author would venture to take the view that when an abscess develops in the region of the ilium in a case of renal infection it is not secondary to a renal infection but forms on the route of the infection as it is proceeding from the pelvis viscera to the kidney. Such abscesses are not rare in those cases of renal infection which are associated with nervous disease or injury, locomotor ataxy or fracture of the spine.

This layer of cellular tissue is sometimes known as the urogenital fascia. In many cases of ascending infection of the kidney it is the actual route by which the infection travels and even in some of the cases in which infection has apparently taken place along the lumen of the ureter this infection has proceeded along this fascia and eventually opened into the ureter along its course and then infected the kidney. It may well be that it is along this

course that infection or irritation has proceeded to produce septic infection of a kidney or kidneys or some of the forms of Bright's disease (*Guy's Hospital Reports* 1929)

The perinephric tissue covers the kidneys and enters the renal hilum, and it is here that lymphatics and blood vessels enter the kidney, thus taking infection into the kidney itself when the pelvic viscera are infected. This conception also offers an explanation of the fact that Wertheim's operation is often not enough in cases of cancer of the female organs. Complete removal of the fascial connections would mean removal of both kidneys.

If this fascia were to be regarded as has been above described, and to be the channel along which irritation as well as infection is conveyed to the kidney, it would explain many of the chronic aches and pains that occur around the kidney in both sexes.

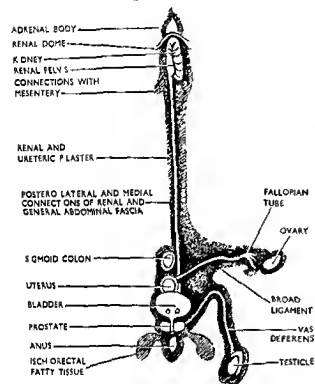


FIG 1  
Vertical diagram of urogenital fascia

It has been stated before that some of the fasciæ may be looked upon as quite fanciful, but it is in connection with such operations as those in which it is sought to fix the kidney for mobility that really serious mistakes are made, especially when the surgeon proceeds to do damage to the tissues which surround the kidney by producing as much fibrous tissue as possible for the kidneys are retained in place by the abdominal muscles and the constant packing of the intestines over the kidneys maintained by these muscles, and not by fascia or connective tissue.

An effort has been made to show that it is necessary to alter our conception generally of the nature of fascia, but it is particularly necessary in connection with the fascia that comes into relation

with the kidney and ureter on each side. The planes of fascia that used to be described were, undoubtedly the result of inflammatory processes such as those following upon a stricture or an enlargement of the prostate in the male, or chronic vaginitis etc. in the female.

All the fascia in this region must be regarded as loose cellular tissue which covers the organ with which it comes into relation. This fascia carries lymphatics, vessels and glands, and it is along this path that inflammation spreads from the primary source. Many of the vague conditions, such as lumbar pain which are too often attributed to mental conditions are explained if the spread of acute or chronic inflammation takes place along this path, e.g. a chronic vaginitis may lead to chronic inflammation of the fascia in the region of the kidney and the ureter (incomplete or sub-total ascending nephritis).

Bearing this conception in mind we may now proceed to enlarge upon previous remarks about the fascia in connection with these organs. Surrounding as it does, all the pelvic viscera, this cellular tissue at the brim of the true

pelvis splits into two ascending columns or ridges, or as they would be called by architects, pilasters, which are pillars attached behind to the structure upon which they lie, and this term may be usefully employed as the fascia is connected behind with the general fascia of the internal abdominal wall. This renal and ureteric pilaster, otherwise known as the urogenital fascia (Fig. 1), spreads up in the paravertebral furrow on each side towards the kidney which it envelops as the renal fascia, containing the perinephric fat, and as it spreads up on the kidney the pilaster comes to form a dome in the region of the upper pole of the kidney, and this dome lies free in the abdomen, except at its base, where it is attached to the pilaster.

In addition to making connection with the general fascia of the abdomen the urogenital fascia establishes other important connections (Fig. 2). Thus it makes connection with the similar tissue in the mesentery, and also with the fascia that covers the adrenal gland. It also makes connection with the fascia that lies in relation to the duodenum and the pancreas and with that covering the gall-bladder on the right side. Hence certain pathological conditions may

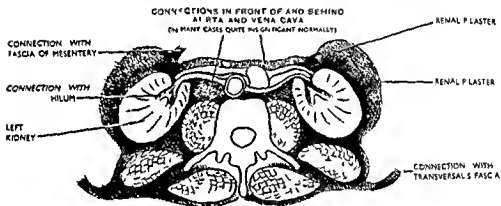


FIG. 2  
Horizontal diagram of urogenital fascia

be due to involvement of the renal fascia, e.g., the adrenal may be involved directly by tuberculous processes, and thus Addison's disease may commence, or the bleeding which occurs in connection with injury of the mesentery may spread to the perinephric tissue, or, primary symptoms of renal trouble may be masked by the secondary symptoms of disease of the gall-bladder, which may follow upon the kidney trouble by involvement of the fascia which is, in fact, common to both organs. It is not too much to hazard the opinion that duodenal ulcer may well be considered sometimes to owe its origin to disease beginning in this renal fascia. Carcinoma of the pancreas which is not rarely secondary to that of the prostate gland will spread along this route.

Over the kidney the fascia sends lymphatic vessels into the kidney itself either through the capsule of this organ or through the layers that spread from it into the hilum of the kidney. For this reason ascending nephritis sometimes is really an acute ascending suppurative interstitial nephritis with secondary tubular changes. Abscesses, too, occur in this ascending pilaster before the inflammation has reached the kidney, but it is none the less an ascending process. This level for abscesses to occur in is especially common in cases of paralytic infections of the bladder. But there are other important connections that are made between the renal pilaster and the genital organs in both sexes.

These connections are perhaps more obvious in the rabbit than in the human subject but in this animal a clue is given to the real condition which is present in the male and female human subject. The fascia as it is traced up from the pelvis is found to surround the uterus and the Fallopian tube and the ovary except near its hilum moreover the fascia may be said to pass rather into the tube than block its entrance into the peritoneal cavity. In the male that portion of fascia which covers the prostate receives a communication from the fascia covering the testis and the vas deferens and this fascia makes connection also with the connective tissue of the urethra. Behind the posterior edge of the levator ani muscle the fascia also makes connection with the fatty tissue in the ischio-rectal space and it is also continuous with that which covers the lower pelvic part of the colon as well as the rectum. By these connections ascending nephritis may follow upon any primary disease in these organs and ascending nephritis is a common cause of a fatal issue in such disease. What may be insisted upon here is that ascending nephritis may follow upon trouble which did not start in the urinary organs.

The glands which lie in the renal and ureteric pilaster by the side of the vertebral column drain the kidneys and the testicles. Hence in the case of the latter organs abdominal tumours above the brim of the pelvis may be secondary to cancer of the testicle and in any case of abdominal tumour in the region of the umbilicus an examination of and for the testicle should be made. Further these lymphatics drain the lower limbs and cases are not unknown in which sepsis of the lower limb has been followed by ascending nephritis. The renal fascia makes no direct connection with the diaphragmatic fascia but as the former structure is the upper part of the urogenital fascia indirect continuity is made by the connection of the urogenital fascia with the transversalis fascia. The fascia spreads across the middle line and at the hilum of the kidney also passes into the renal pelvic region. These remarks imply that inflammation may spread from one kidney to the other. The following summary may now be made.

The urogenital fascia is a common path for ascending nephritis to spread along. Other organs besides the kidney which have a fascial connection with the urogenital fascia may give rise to ascending nephritis either of an acute or a chronic nature and this fascia is important in deciding if an abdominal tumour is secondary to trouble in the testicle and sepsis of the lower limb may be followed by ascending nephritis. Some of the common diseases of the gall bladder and of other organs may be attributed to these connections. Ascending nephritis does not only concern the urinary surgeon and may indeed end life in gynæcological conditions.

A RALPH THOMPSON

## CHAPTER II

### THE DEVELOPMENT OF THE KIDNEYS AND THEIR CONGENITAL DEFECTS

**T**HE parts of the embryo which form the kidneys and the ureters are the Wolffian ducts and the metanephros on each side and the cloaca at the caudal end. The Wolffian ducts appear first. Each lies in the intermediate cell mass and is connected with the mesonephros in front and the cloaca behind. The duct becomes connected with the genital gland. The metanephros forms the main mass of the permanent kidney whilst the cloaca is of importance in connection with the formation of the bladder and the ureter. Included in the term bladder the first part of the urethra in the male and the whole of it in the female must be noted.

The Wolffian ducts pass caudally to join the cloaca, one on each side of the middle line. The site of the opening is very constant but it may open at other situations than the normal. This aberration may be responsible for some ureteric deformities for from the Wolffian duct a diverticulum springs which forms the ureter. A cleft appears between the duct and its diverticulum and this passes caudally so that the diverticulum which forms the ureter becomes completely separated from the duct and each has now a separate opening into the cloaca. At first the ureter lies on the dorsal side of the duct but later a twisting takes place so that the ureter comes to lie on the ventral side of the duct. The duct forms the vas deferens in the male and the duct of Gaertner in the female but it may in cases of congenital defect form an aberrant ureter. When the bladder is differentiated as a distinct cavity the ureter passes in a cephalic direction and makes connection with the metanephros and the continuity of the kidney and the ureter is established. Owing to the twisting of the Wolffian duct and the ureter some of the anomalies of the course of the ureter may be explained.

The ureter as it passes forward to the kidney develops two or three secondary processes which form the calyces of the kidney and also later on the collecting tubules and the remainder of the metanephros forms the main mass of the secreting tubules of the organ. Failure to unite of the two parts may result not only in the production of some forms of congenital cystic disease but also may be responsible for the formation of certain malignant tumours and the fact that in the intermediate cell mass the main mass of the muscles is developed serves to remind us of the possible occurrence of malignant muscular and renal tumours which are found at birth or may develop very shortly after birth. But it must be confessed that these possible occurrences do not always square with our present conceptions of the development of these organs.

The steps in the development of the kidney and ureter are in the province of the embryologist but much may be learnt by the surgeon during an examination of macroscopic foetuses. At full term the kidneys are relatively large and are lobulated especially on the anterior surface and they are surrounded by the loose perirenal tissue which may be loaded with fat. They lie at a lower level than in the adult usually the lower pole is below the level

of the crest of the ilium. The left kidney is on the same level as the right, and may indeed be at a lower level. The angle which the lumbar vertebrae make with the sacrum is only one of about  $20^{\circ}$  after birth but before the erect attitude is adopted this angle becomes much more acute. The kidneys are developed in the skeletal pelvic cavity and ascend during foetal life into the abdomen, and only attain their normal level after birth has taken place. The notch on the inner border of the kidney which indicates the hilum is small but well marked, and it is directed inwards. It is only after birth that the hilum becomes wider and its plane as well as that of the kidney is shifted to an oblique one.

The renal arteries and veins respectively arise from the aorta and pass into the vena cava at the same level as in the adult, but are more obliquely placed in their course. In addition to these main vessels, segmental vessels also run to both the metanephros and the mesonephros. These usually disappear but may remain as aberrant blood-vessels. It should be noted in this connection that aberrant blood-vessels pass to the upper part of the kidney as well as to the lower, but that only the latter can press upon the ureter, and lead to the production of symptoms (Lucas-Kecene).

The congenital defects of the kidneys and ureters may be divided into renal, vascular and ureteric, but classifications are often found, in their component parts to overlap. Although defects may be congenital that is present at birth some of them are not due to developmental errors but to intra-uterine disease, as was pointed out by Sir Samuel Wilks long ago in connection with caliculae defects.

Congenital defects of the kidneys may be classified under the following heads

- 1 Position high, low, and to one side
- 2 Size large small
- 3 Shape pyriform disc-shaped
- 4 Number increased or decreased
- 5 Constitution composite renal mass
- 6 Union congenital cystic disease
- 7 Chromaffin rests
- 8 Defects of the vascular arrangements

#### ABNORMALITIES OF LEVEL

*A Upward displacement*—Such displacement may be quite small, and associated with the presence only of eleven ribs and may cause much difficulty during a renal operation. The condition is not common, one case occurring during twenty-six years at Guy's Hospital.

*B Downward displacement*—This occurred in six of 13,000 cases and equally in the two sexes, but unless the surgeon is familiar with the true level of the crest of the ilium he will be cautious in taking this as the standard of level for making his observations. One or both kidneys may be found at a lower level than usual and the low kidney may be found within the skeletal pelvis in which case the cecum may descend into the lowest part of the iliac fossa. The arteries in such cases usually arise at or near to the normal level, in which case they are directed downwards and outwards to a normal hilum, but the arteries may arise from the common or internal iliac, or from the lower part of the aorta, never from the external iliac. Displacement is not to be confused with displacability.

It may be stated that except in rare cases the kidney is never so mobile as it is or has been, when pulled up into a lumbar wound or even through

such a wound. It is wrong for a surgeon to speak of a kidney as being mobile when it is in one of these positions. Surgeons are so apt to find mobility and no other abnormality when they cut down upon the kidney that their observations may be of small value and in any case mobility is not a congenital condition but the term floating may be very properly used for that condition in which the kidney is found to be capable of displacement over a wide area owing to the presence of a definite mesentery. Such conditions occurred once in 6 000 cases.

C Mesial displacement—One kidney may be found lying over the vertebral column.

### ABNORMALITIES OF SIZE

Both kidneys may be found smaller than usual rarely larger.

Small kidneys are not associated with long life. Kidneys may be unequal

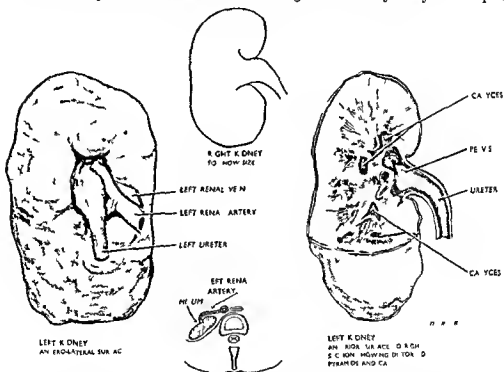


FIG 3

in size and such inequality occurs once in a thousand cases. The side incidence is equal but males are twice as frequently affected as females. The smaller kidney may have a deficient blood supply or may be cystic which facts seem to show that there is more than mere lack of development as a cause of the inequality. The large kidneys associated with diabetes and alcohol taking are not congenital conditions.

### ABNORMALITIES OF SHAPE

These may be associated with differences in level and it may be impossible to state which is the primary deformity.

Persistent lobulation of the kidney is found commonly but in a very few cases the condition may pass into very deep division and definite clefts.



**Solitary kidney**—This may be actual or functional, true or false. Only one kidney may have been developed or one kidney may have been affected by disease. For the condition of true solitary kidney to be accepted, the ureter and the ureteric orifice in the bladder and the vessels must be absent.

If the slightest sign of any of these structures is found, then there should rightly be some doubt that the condition is truly solitary. It may be functionally so. Every effort must be made before removal of a kidney to ascertain the presence or otherwise of the other organ. It is in emergency surgery that the solitary kidney may be removed, but there is less excuse for this disaster if it be recollected that such kidneys are usually cut down upon by the abdominal route and when this route is adopted the presence of both kidneys may be proved easily by palpation before nephrectomy of one is begun.

**A. FALSE SOLITARY KIDNEY**—In these cases some remains of the ureter or vessels are present. In the Guy's Hospital series the right kidney was present in seven cases out of 13,000; three were females and four males. The left kidney was present in four cases out of 13,000; two were females and two males. In all the cases there was some evidence that the ureter or vessels had developed in connection with the other kidney which had atrophied. The expectation of life is not so good in females as in males.

**B. TRUE SOLITARY KIDNEY**—In these cases there is no ureter, no ureteric orifice and there are no renal vessels (Fig. 5). The incidence has been found to be as follows—

Right kidney present in ten cases out of 13,000; four were females and six males.

The left kidney present in six cases out of 13,000; there were six males and no females.

The expectation of life is not so good in females as in males, but this is not entirely due to accidents of pregnancy or labour. Unlike what is found in the former class, genital lesions such as uterus unicornus are found in this second and true class. In both classes the adrenals are present and are found to be supplied by adrenal vessels arising direct from the aorta.

**Increase in number**—In connection with double ureters, when it is suspected that the kidneys are double also, it may be found that the kidneys are increased in number. Thus a second kidney may be found within the hilum of the kidney, but cases where two apparently normal kidneys of the same size and shape are

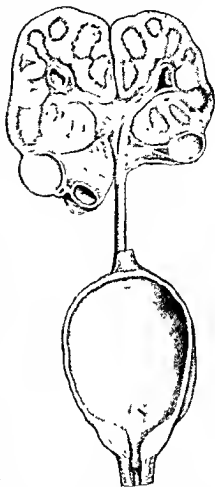


FIG. 5

Congenital absence of one kidney and ureter. The single renal mass has been opened and everted. The cysts at the lower pole probably represent the absent organ. The orifice of the single ureter is represented by a bristle in the mid line. Post mortem specimen removed from a male of 6 months.

found together are not at all common but we shall see that this condition is to a certain extent described later under the heading of "composite renal mass"

### ABNORMALITIES OF CONSTITUTION

Under this heading will be included the condition known as horseshoe kidney as well as that of double kidney occurring on one side only. The two conditions may be put together under the term "Composite Renal Mass"



FIG. 6

Instrumental pyelogram of a horseshoe kidney showing some hydronephroses on both sides in a woman aged 31. Note the inward direction of the lowest calyces and the relatively low position of the organ. (Mr. Jocelyn Swan's case)

#### Composite renal mass—

- A Bilateral Horseshoe kidney
- B Unilateral
  - (a) Kidneys joined in series
  - (b) Kidneys joined in parallel

**BILATERAL RENAL MASS OR HORSESHOE KIDNEY**—This has been reported in fourteen cases out of 13,000, three were females and eleven males. The expectation of life for a prolonged period after birth was found not to be so good in females as in males of whom one reached the age of 70, but 50 per cent. of males died in infancy. Females apparently do survive birth but die at a younger age than the surviving males, although pregnancy and labour are not responsible for death.

Horseshoe kidney invariably lies at a low level. The inferior poles are united across the midline by true renal tissue, although a rare case is recorded by Struthers of the union being by fibrous tissue, and it may be

added that those cases are not included in which the kidneys lie in a normal position and have become united by inflammatory fibrous tissue, so that their upper poles are joined by this across the mid-line. The horseshoe kidney rises out of the pelvis as a rule, but does not ascend above the level of the fourth lumbar vertebra. The further ascent of the united kidney is prevented by the presence of the inferior mesenteric artery, and if it tries to ascend further than this it is shifted off to one side, particularly the left, and thus forms one of the varieties of unilateral renal mass.

An intermediate condition is found in which the isthmus pivots upon this artery and the whole mass comes to lie more on the left than on the right side. Horseshoe kidneys may be associated with congenital skeletal deformities especially of the lower limbs, but cases in which syndactylism has been found in the upper limbs are also on record. But horseshoe kidney is not often found with other genital or urinary defects, only about one case in 13 000.

The ureters are usually two in number, and arise from the inner border of the upper free part of each lateral mass, and they run across the isthmus of the organ. The vessels which supply the lateral masses have a normal origin, though they may arise lower than usual but the isthmus may be supplied by another artery which always rises from lower down the aorta than is usual. It is believed by some authorities that the isthmus may be a third part of a horseshoe kidney, and some support is lent to this view by this separate blood supply to it. The hilum of the horseshoe kidney are developed on the inner borders of the lateral masses. Each lateral mass has one pelvis, of which the lower part is often large and passes towards the mid line. In some cases the two pelves are united at their lower ends



FIG. 7

Instrumental pyelogram of a horseshoe kidney, showing a partial crossed ectopia of the right segment: the pelvis of which occupies the mid line. There is a stone in the left pelvic ureter and another in the right renal pelvis. (Mr I. Maassels's case.)



FIG. 8

Instrumental pyelograms of a horseshoe kidney in a woman aged 44. Note that the lowest calyces on the right are to the inner side of the pelvis (Mr. Cyril Nitch's case)



FIG. 9

Instrumental pyelogram of a horseshoe kidney in a woman aged 20. Note the downward position of some of the calyces (Mr. Sir J. Joly's case)

One pelvis is thus formed and there may be only one ureter for the whole mass. Sometimes the two lateral parts may be very asymmetrical in size.

**UNILATERAL COMPOSITE RENAL MASS—(1) Kidneys joined in series—**This condition may be regarded as that in which a horseshoe kidney developed and tried to ascend as usual and was not fully prevented by the inferior mesenteric artery—which however shifted the mass to one side usually the left. The left side of the mass passes upwards and the right side passes across the mid line and lies at a lower level. Thus the left mass lies above the right and the concavity of the whole looks to the right and the whole mass may be mistaken for a single kidney and is looked upon as a solitary kidney lying on the left side. As long ago as 1769 Morgagni pointed out that this was not the case and he recognized that the condition was really a double kidney lying on the one side. Its connection with horseshoe kidney is further shown by the fact that in some cases the middle part of the mass is supplied by a distinct artery just as the isthmus of a horseshoe kidney may be. The blood vessels arise in series at regular intervals from each other and from the same side of the aorta as that upon which the mass is lying. The front and lower surface of the mass is traversed by a groove vertical in direction and lodging the right ureter. During an operation this ureter is found lying by itself and may be difficult of identification. The right ureter passes down in front of the other ureter and opens in the bladder by a normal right ureteric orifice whilst the left or upper ureter passes vertically downwards to enter the bladder by a normal left ureteric orifice. It is thus easy for one to see how difficulties may arise at an operation.\*

**(2) Kidneys joined in parallel—**This condition is very rare only one case in 20 000 and it is referred to by Sir Samuel Wilks. It occurred in 1875.

The two kidneys lay parallel with each other and whilst the true left kidney lay practically in its usual position the right kidney was rotated so that its hilum looked to the right. The mass lay on the left side of the abdomen. One ureter passed down in a deep groove between the two kidneys whilst the true right ureter passed down on the right side of the right portion. The arteries entered the upper pole of each kidney one to each part but there were two additional arteries which entered the lower part of each mass. The veins and ureters emerged from a normally placed hilum in each kidney save for the fact that the right kidney was twisted on a vertical axis. The veins entered the vena cava just above its level of formation.

#### ABNORMALITIES OF UNION

**Congenital cystic kidney—**As this subject will be dealt with later in this book it is sufficient here to say that true congenital cystic kidney is very rare and one extensive investigation showed that it occurred twice only in 13 000 cases. In both cases congenital bony lesions were found as well as the renal condition viz syndactylism and talipes.

#### CHROMAFFIN RESTS

This name is suggested here as being more exact than that usually employed viz adrenal or suprarenal rests for it brings such rests into series with the chromaffin bodies which may be found along the course of the aorta.

\* In one clinical case which occurred in the author's practice the true right ureter was divided at an exploratory operation. As the divided ends remained in exact apposition they were not sutured. The wound was drained. The patient lived for very many years at least fourteen after the operation and there was clinical evidence that the ends of the ureter had united.

and run downwards to the region of the prostate in the pelvic cavity. They occur once in 634 cases but one simple coronal section of the kidney is not sufficient to prove their absence and for this reason the above ratio is probably a minimum. The figures are as follows —

	Females	Males
Left side	2	1
Right side	7	3
Both sides	0	2
Side not noted	1	4
Ectopic adrenal	2	3

Chromaffin rests are situated invariably at the upper pole of the kidney and vary in size from a pin's head to a long linear area situated near the upper pole of the kidney. It is noteworthy that only one of these cases survived to the age of 63 and that five of the males died with some malignant condition but only one of the females died with a similar condition present.

**Ectopic adrenal**—The adrenal body may be found in an unusual position. Thus it may be found situated behind the kidney or in the hilum of that organ. It is rare for an ectopic adrenal to be found as a definite functioning organ within the capsule of a kidney.

#### DEFECTS OF THE VASCULAR ARRANGEMENTS

**Aberrant blood-vessels**—Clinical experience suggests that aberrant blood vessels give rise to urgent symptoms but in spite of this suggestion only six cases occurred at Guy's Hospital in twenty six years. Investigations by the surgeon at the time of operation are usually of small value and at autopsies the condition is often missed owing to the examination of the kidneys *ex situ*. For these reasons no very definite attention should be paid to statistics in this connection. But post mortem investigations appear to confirm the clinical findings: ten cases were found in 13,000—eight females and two males. The aberrant blood vessels which produce symptoms do so by obstructing the ureter and in order to do this the vessels must pass to the kidney below the hilum and the origin of the ureter. The aberrant vessel is usually arterial and arises from the lower part of the aorta or from the common or internal iliac arteries but not from the external iliac artery. Kinking of the ureter over the artery may occur and give rise to the urgent symptoms which have been noted. Specimens of the early division of the main artery show that this condition is associated with a distinctly segmental arrangement of the branches and that the ureter may be kinked over the lowest branch. (In fact obstruction of the ureter by non aberrant vessels occurs more commonly than by aberrant vessels see p 91 *et seq*—Ed.) The various levels at which the aberrant arteries arise from the aorta or other vessel indicate their segmental origin and in this connection it should be noted that aberrant blood vessels may pass into the kidney at a higher level than the hilum. It is very rare for the condition of aberrant blood vessels to occur on both sides—one in 13,000 cases. The main vessels are more variable than any other of the large vessels of the human body (Young and Peter Thompson).

NOTE—The above statements are based on a large number of autopsies performed at two large hospitals and one children's hospital in London.

The author wishes to state that practically any of the various numbers of the *Journal of Anatomy and Physiology* (later *Journal of Anatomy* from 1890 to 1930) have accounts in some cases excellent accounts of congenital deformities of the Upper Urinary Tract.

A RALPH THOMPSON

## CHAPTER III

### PHYSIOLOGY AND TESTS OF RENAL FUNCTION

#### PHYSIOLOGY

**STRUCTURE**—The human kidney like that of other vertebrates is made up of a number of individual functional units each known as a *nephron* and consisting of Bowman's capsule and a renal tubule (Fig 10). There are about a million *nephrons* in each kidney and a knowledge of their structure is necessary for an appreciation of the mechanisms whereby the kidney is enabled to preserve the composition of the blood and allow such fluid and solids as are not required by the body to escape in the urine. This process begins at the glomerulus which is a tuft of capillaries invaginated into Bowman's capsule and forming with it the Malpighian corpuscle. The capsule is lined by a parietal layer of flattened epithelial cells continuous with those of the renal tubule where it is reflected over the glomerulus as a visceral layer the cells lose their outline and form a syncytium which is separated from the capillary endothelium by a basement membrane. It is through this extensive thin area composed of fused capillary endothelium basement membrane and visceral capsule that filtration of fluid occurs.

The capsular space communicates directly with the lumen of the proximal tubule this is convoluted and is lined by cuboidal cells having a brush border. It leads by a straight descending limb to the thin segment of the loop of Henle. Here the lining epithelium is flattened and the partly compressed cell nuclei bulge into the narrow lumen of the tubule. The thin segment extends for a variable distance around the loop of Henle to the ascending limb it is only found in mammals and is least developed in the more primitive forms. Its difference in structure from the rest of the tubule is suggestive of a difference in function.

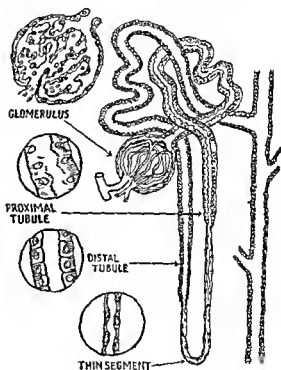


FIG 10

Diagram showing the essential features of a typical nephron in the human kidney.

(Homer Smith *Physiology of the Kidney* 1937)

The distal tubule leads from the ascending limb of the loop through a straight to a convoluted segment which lies near the glomerulus of origin. It is lined at first by cuboidal cells which become progressively more columnar, they show basal striations but no brush border.

The collecting tubules are lined by a single smooth layer of cells of varying height, it is probable that they serve solely as ducts. They lead into the ducts of Bellini which are lined by columnar epithelium and open at the apex of the pyramids. All the tubules are enveloped in a basement membrane. The length of the tubule in man is about 3 cm. The glomeruli and convoluted tubules lie in the cortex, and the remainder of the tubule in the medulla of the kidney.

**Blood supply**—After entering the hilum of the kidney the renal artery divides into ventral and dorsal end arteries. Their branches run between the lobules and are connected by arterial arches. From the interlobular arteries short twigs are given off at intervals the afferent vessels of the glomeruli, they break up into the glomerular capillaries. The blood is carried from the glomeruli by efferent arterioles which break up again into a capillary network close to the tubules which are thus supplied with blood which has already passed through the glomeruli. There is rarely any direct arterial supply to the tubules. The peritubular capillaries converge into veins which join the arcuate veins lying in the concavity of the arterial arches, and these join finally to form the renal vein.

There is evidence to suggest that the blood pressure in the glomerular capillaries is 70-100 mm Hg.

### THEORIES OF RENAL FUNCTION

**Historical**—Bowman's theory of 1842, based on anatomical grounds, was elaborated by Heidenhain in 1874, the kidney was considered comparable to other secreting glands, water and salts being secreted by the capsule, and waste products by the cells of the tubules. Ludwig in 1844 suggested that the glomeruli acted as filters for the plasma, the tubules effecting concentration of the urine by diffusion of water back into the blood. Cushny in 1917 accepted the view that there were two processes concerned in the secretion of urine, filtration in the glomeruli and reabsorption in the tubules of a peritubular "Locke's fluid" best adapted for the tissues. In 1924 Richards proved the existence of glomerular filtration and tubular reabsorption in the frog by cannulating Bowman's capsule and the tubules and comparing the fluid with the plasma and the urine, and Marshall demonstrated the possibility of excretion by the cells of the tubules of most of the ordinary urinary constituents and of foreign substances.

It is generally accepted that the following processes occur in the human kidney.

1. **GLOMERULAR FILTRATION OF PLASMA LESS ITS COLLOIDS**—The filtering force is the glomerular blood pressure less the osmotic pressure of the plasma proteins, and is ultimately provided by the heart. The average volume of filtrate in "ideal" man (surface area 1.73 sq metre) is about 120 c.c. per minute, with a renal blood flow of 1,000 c.c. per minute, of which about 550 c.c. is plasma, it follows that about a fifth of the plasma passing through the glomeruli is filtered into Bowman's capsule. The normal glomerular epithelium is impermeable to substances of higher molecular weight than about 70,000 (e.g. serum albumen 72,000, serum globulin 170,000) but will allow the passage of injected haemoglobin (67,000) and egg-albumen (35,000),



the number working so further decreasing the urinary output. During diuresis especially when produced by intravenous saline the number of patent glomeruli is increased and a bigger filtering surface produced.

Although much of this evidence is derived from rabbits it seems likely that in man similar intermittence may occur from physiological causes.

### TESTS OF RENAL FUNCTION

**General considerations**—In urology as in every branch of surgery the clinical condition of the patient is of more importance than the results of laboratory tests. The urologist is concerned with the total renal function particularly where there is an obstructive urinary lesion and it is in such a condition that he can receive considerable help from the biochemist in assessing the amount of renal impairment. In unilateral renal lesions amenable to surgery he is concerned mainly with the ability of the remaining kidney to excrete waste products and prevent their accumulation in the blood. Excretion is the main physiological function of the kidney but deficient excretion of a substance in the urine does not necessarily indicate impaired renal function. For example there may be deficient excretion of water or chloride in myocardial weakness or in vomiting or diarrhoea although the kidneys are normal. Conversely excretion of dissolved substances may be complete even when there is renal impairment through the mechanism of a compensatory polyuria. The normal kidney has such power of accommodation that it can produce a large quantity of dilute urine when much water is ingested or a small amount of concentrated urine when little is taken. In renal impairment this power of accommodation is lessened. Renal impairment signifies some loss of concentrating power. If the compensatory mechanism of polyuria fails there is retention in the blood of products which should be excreted and renal insufficiency results. It follows that an estimation of renal function requires examinations of the urine and of the blood. In their simplest forms these tests are carried out separately but for more accurate results a combined examination of the two factors is undertaken. Extreme mathematical accuracy however is neither obtainable nor necessary. The following tests will be described—

#### A Urinary tests

- 1 Fluid intake and output
- 2 Specific gravity test
- 3 Urea concentration test
- 4 Phenol sulphone phthalein test
- 5 Indigo carmine test

#### B Blood tests

- 1 Blood urea
- 2 Non protein nitrogen
- 3 Urea nitrogen
- 4 Creatinine

#### C Combined tests

- Urea clearance

#### D Radiographic tests

- Excretion urography

#### A Urinary tests—(Tests of elimination and concentration)

1 **THE TEST OF FLUID INTAKE AND OUTPUT**—Normally the quantity of fluid ingested and the volume of urine should run parallel and any serious divergence may indicate renal impairment.

*Technique*—The patient is given 1 200 c.c. of water to drink within half an hour. All the urine passed is collected for the next four hours, and practically all the 1 200 c.c. should be recovered, the greater part in the first two hours. In renal impairment the excretion is delayed and only a part is excreted in four hours.

In renal impairment the delay in water excretion is associated with a low maximum specific gravity of the urine. Where there are pre-renal causes of diminished excretion (e.g. circulatory weakness, oedema, diarrhoea or vomiting) the maximum specific gravity is high. It is therefore important to record fluid intake and output and the specific gravity in all urological cases.

**2 TESTS OF SPECIFIC GRAVITY**—The power of accommodation of the kidney is most easily observed by noting the normal variations in the specific gravity of the urine, and although equal weights of dissolved substances alter the specific gravity in different degrees for clinical purposes the specific gravity can be taken as a measure of the total concentration. In progressive renal damage, impairment of concentrating power is the earliest recognisable change, inability to concentrate the urine above a specific gravity of 1010 after fluid restriction represents the maximum impairment of concentrating power (Fishberg). Inability to produce a dilute urine after copious drinking follows later and ultimately the specific gravity tends to become fixed under all conditions at about 1010.

*Technique*—The patient is given his usual evening meal at 6 p.m., it should contain little fluid but much protein. He has nothing more to eat or drink until the test is completed. All urine passed during the night is discarded but the first specimen passed on waking is kept (1). He remains in bed for one hour and passes urine again (2), he should then get up and after another hour empty his bladder again (3). The specific gravity in at least one of the specimens 1, 2 or 3 should be higher than 1022 if the kidney function is normal.

This test is invalidated if there is evacuation of oedema fluid as may occur in cases of cardiac failure when the specific gravity will be low. The test gives in other respects a reliable index of renal impairment but not of renal insufficiency unless taken in conjunction with blood chemistry tests. It has the disadvantage of requiring a reduction of fluid intake which is not desirable in surgical urological cases.

**3 UREA CONCENTRATION TEST (Mclean and de Wesselow)**—In renal impairment all the constituents of the urine are affected by the diminution in concentrating power, urea, a normal component of the urine, is innocuous when given by mouth and its ingestion leads to a rise in the plasma urea. When the renal function is normal the excess urea is filtered by the glomeruli and although some is probably reabsorbed by the tubules the greater part is excreted in the urine. The urea concentration test is based on these facts.

*Technique*—The test is carried out in the morning after a night of abstinence from fluid. The bladder is emptied and the patient given 15 gm. of urea by mouth dissolved in 100 c.c. of water suitably flavoured. The bladder is emptied after one, two and three hours, the volume of each specimen is noted and the percentage of urea estimated. If the kidney function is normal the concentration of urea should be at least 2 per cent in one of the specimens, the highest figure is usually in the second hour specimen.

The test, which is extensively used in cases of prostatic obstruction, is interpreted somewhat differently by different surgeons. A concentration of

2 per cent is generally considered adequate for one stage prostatectomy whilst below 1.8 per cent there is serious risk of uræmia. The concentration however depends on the volume of urine as well as the amount of urea and if the volume exceeds 130 c.c. per hour the percentage of urea may be below the accepted minimum even if the kidneys are normal. As urea is itself a diuretic this condition does sometimes arise. It may therefore be more reliable to interpret the test in the terms of total urea excretion and to assume a satisfactory function only if at least 1.5 gm. of urea is excreted in each hour.

The result of the test depends also on absorption of urea from the intestine and on the initial concentration of urea in the blood. With a high blood urea in severe renal impairment it is possible to have a high concentration of urinary urea.

In addition to these estimations of normal excretory products the function of the kidney may be tested by its power to eliminate foreign substances introduced into the blood stream.

**4 PHENOL SULPHONE PHTHALEIN TEST (Rowntree and Geraghty).—**Phenol red or phenol sulphone phthalein (P.S.P.) is a non-irritating substance which is almost completely excreted in the urine in a relatively short time when introduced into the blood stream. About 20 per cent of it is free in the plasma and is filtered by the glomeruli whilst the remaining 80 per cent is bound to the plasma proteins and is eliminated by tubular excretion. In an alkaline solution it has a bright red colour suitable for colorimetric investigation. The presence of blood in the urine will vitiate the calculation.

**Technique.**—The patient who should be at rest in bed drinks 300 c.c. of water. Twenty minutes later the bladder is emptied by a catheter which is tied in and an intravenous injection of 6 mg. of phenol sulphone phthalein in 1 c.c. of sterile water is given. Urine from the catheter drips into a test tube containing a drop of 25 per cent sodium hydroxide and the time of the first appearance of a pink colour is noted. The catheter is then closed by a spigot for one hour after which all the urine collected in the bladder in that time is removed. This is repeated for a second hour. The amount of dye in each specimen is estimated as follows. 10 per cent sodium hydroxide is added until the maximum red colour appears. The urine is diluted to 1,000 c.c. and compared in a colorimeter with a standard solution whence the percentage of dye can be estimated.

In a normal subject the dye begins to appear in about four minutes. In the first hour 60 per cent and in the second hour 20–30 per cent is excreted giving a total of 80–90 per cent in two hours.

**Variations.**—(a) The amount of water given before injection is sometimes increased to 1,000 c.c. but the diuresis produced will raise the amount of dye excreted and may mask renal impairment.

(b) The injection is given intramuscularly. Excretion is then slower. The dye appears in about ten minutes, about 50 per cent being eliminated in the first hour and 20 per cent in the second.

(c) The time intervals of collection are shortened to half hourly or even quarter hourly.

The interpretation of the test in surgical cases also varies. An excretion of only 20 per cent in two hours certainly indicates renal impairment yet this figure has been accepted as the level at which prostatectomy may be undertaken. It is a test which is more often used in America than in this country.

**INDIVIDUAL RENAL FUNCTION.**—The test is adaptable for the study of the function of each kidney separately. Ureteric catheters (which should be as

large as the ureter can take to prevent leakage) are passed and the urine from each collected. The injection should be intravenous and should not be given until the catheters are seen to be draining satisfactorily. Colorimetric estimations of the concentration of the dye are made as before.

**5 INDIGO CARMINE TEST**—Indigo carmine is also eliminated by tubular excretion but only about 25 per cent is excreted by the kidneys. It is therefore not suitable for quantitative estimation.

The blue colour can be seen in the urine without the addition of an indicator and it is thus of value as a test of differential renal function when observed cystoscopically. It can also be used as a test of total renal function if the patient can pass a little urine at five minute intervals or if a catheter is passed, or if there is already a suprapubic catheter in position.

**Technique**—4 c.c. of a 0.4 per cent solution of indigo carmine is injected intravenously. If the kidney is normal a blue efflux will be seen from the ureteric orifice in from four to seven minutes. The colour will become progressively deeper with each efflux. If the urine is draining from a catheter the development of a good blue colour in ten minutes is regarded as evidence of satisfactory renal function.

**Variations**—The injection of 10 c.c. of solution is sometimes advised but this amount is unnecessarily large. Under no circumstances should a concentration of more than 0.4 per cent be injected because the drug is not completely excreted; a 4 per cent solution used in error has been known to produce a generalized blue coloration of the skin and small emboli in the cerebral capillaries (Macalpine). The injection can be given intramuscularly in which case the onset of excretion is delayed for about twenty minutes.

Although the test is one of the simplest it is one of the most useful in surgical urology. It gives reliable information during cystoscopy of the presence or absence of two functioning kidneys during suprapubic drainage prior to prostatectomy; it can be used as a rapid bedside record of progress and will indicate whether the time is ripe for further more decisive tests.

**B Blood tests**—(Tests of retention)—The tests of elimination so far described will give an indication of renal impairment. It has been pointed out however (p. 27) that by means of a compensatory polyuria the total amount of waste products excreted by the kidney may still be normal. It is only when the amount of renal damage (represented by a diminished number of functioning glomeruli) is further increased that waste products begin to accumulate in the blood and a state of renal insufficiency supervenes. Even this condition is not necessarily a permanent change as is shown by the recovery of function in surgical cases after the relief of obstruction of relatively short duration.

**1 BLOOD UREA**—The degree of renal insufficiency can be gauged by an estimation of the amount of the nitrogenous end products of protein metabolism in the blood. Urea is the principal substance; it is in the main an exogenous product derived from ingested protein but in conditions of starvation it is partly endogenous when it is a product of the breaking down of tissue proteins used for supplying energy.

**Technique**—With the patient fasting 10 c.c. of blood are withdrawn from a vein placed in an oxalate tube shaken and sent to the laboratory. If the syringe used has been sterilized in alcohol it must be well washed out with sterile water or the blood will clot.

**Interpretation**—The normal figure for the blood urea is 20 to 40 mg. per 100 c.c. in renal insufficiency the amount rises. Animal experiments show

that three quarters of the available renal substance must be destroyed before the blood urea is affected. Whilst elevation of the blood urea depends on the severity and duration of the renal damage it is also affected by age by the fluid intake the quantity of protein in the diet and the amount of katabolism of tissue protein by liver damage by circulatory weakness and by such causes of pre renal deviation of fluids as vomiting and diarrhoea. It cannot therefore be regarded as an ideal test of renal function and in practice an isolated blood urea estimation may be misleading yet it is a test of considerable practical value to the surgeon especially in prostatic cases in showing the need for preliminary drainage a blood urea of more than 50 mg per 100 c.c. is usually considered an indication for a two stage operation. Where the blood urea is high it will fall rapidly after drainage unless there is considerable permanent renal change it will indicate the relief of renal insufficiency before there is evidence of restored concentrating power as shown by the indigo carmine test. It is advisable to rely on the latter in judging whether the patient is fit for prostatectomy rather than on the blood urea alone but a persistently raised blood urea after drainage in a prostatic case is evidence of serious renal damage.

**2 NON PROTEIN NITROGEN**—The non protein nitrogen (N.P.N.) includes the weight of nitrogen in all the soluble nitrogenous bodies of the plasma exclusive of protein i.e. urea uric acid amino acids ammonia and creatinine. It is normally 20 to 40 mg per 100 c.c. and in renal insufficiency from surgical causes its rise is usually parallel to that of the blood urea.

**3 UREA NITROGEN**—Urea nitrogen makes up about half of the non protein nitrogen or of the blood urea. It is possible to estimate the distribution of nitrogen throughout the constituents of the blood but if the sum of the nitrogen content of the individual non protein nitrogenous bodies is compared with the total non protein nitrogen there is found to be a deficiency. This unknown fraction is also increased in the nitrogen retention of renal insufficiency if the urea nitrogen is subtracted from the non protein nitrogen a value is obtained for non urea nitrogen which has been called the *uræmic moiety*.

In renal insufficiency the urea nitrogen may rise proportionately more than the non protein nitrogen and form 80-90 per cent. of the total.

**4 CREATININE**—The amount of creatinine in the blood is believed to be independent of the diet it is a waste product derived from the endogenous metabolism of the creatine of muscle. It is excreted by the kidneys by glomerular filtration. The normal amount of creatinine in the blood is less than 2 mg per 100 c.c. figures above 3 mg indicate considerable renal damage whilst above 5 mg the outlook for recovery is poor. In renal insufficiency the blood urea rises before the blood creatinine whilst in the late stages of uræmia the creatinine may rise sharply even to 30 mg per 100 c.c. as a result of toxic destruction of muscle.

The practical value of blood chemistry estimations other than the blood urea is doubtful in surgical cases and multiple investigations of this kind frequently lead to waste of time without any real increase in useful information. The blood urea gives a reliable index of renal insufficiency within the limitations already stated and its value is enhanced by a simultaneous estimation of the urinary urea. If this is low (e.g. less than 2 per cent.) with a raised blood urea it is an indication of renal insufficiency.

**C Combined tests**—The limitations of individual tests whether of concentration or of retention have been indicated and the value of combining them pointed out. Apart however from the study of the urine and the

blood there is also the time factor or rate of excretion to be considered, and attempts have been made to embody these three factors in one test of renal function. The Ambard Constant, Maclean's Index and the Addis Ratio represent steps in the development of the test known as the Urea Clearance Test.

**THE BLOOD UREA CLEARANCE TEST** (Moeller, McIntosh and Van Slyke)—The term *clearance* was first used in connection with the excretion of urea and is defined as the volume of blood (in c c) which would be cleared of urea by the kidneys in one minute. The clearance is a virtual volume as all the blood passing into the glomeruli is not cleared of urea by the kidneys. A clearance of 60 c c means that the amount of urea excreted in one minute is equal to that found in 60 c c of blood.

In a healthy adult, if the blood urea remains constant, when the volume of urine excreted reaches 2 c c per minute the excretion of urea attains its maximum value, further increase in the rate of excretion of urine has no effect on the rate of excretion of urea which is directly proportional to the urea content of the blood. The *maximum clearance* (Cm) is therefore a constant which is found to average 75 c c. It is calculated from the formula —

$$Cm = \frac{U}{B} \times V$$

Where U is the urinary urea in mg per 100 c c

B is the blood urea in mg per 100 c c

V is the volume of urine in c c per minute

When the volume of urine excreted is less than 2 c c per minute the rate of excretion of urea depends on the rate of excretion of urine, and falls in proportion to the square root of the volume. This *standard clearance* (Cs) is found to average 54 c c and is calculated from the formula —

$$Cs = \frac{U}{B} \times \sqrt{V}$$

In order to carry out the test it is therefore necessary to collect all the urine passed in a given measured time, say one hour, to estimate its percentage of urea, and to estimate the blood urea. It is usual to repeat the collection for a second hour as a check. As it is important that all the urine excreted by the kidneys in the given period shall be measured it is necessary to catheterize any patient in whom there may be residual urine or who has difficulty in voiding completely to order, the catheter is tied in for the duration of the test.

**Technique**—The examination is performed in the morning after breakfast, or in the afternoon after lunch, no coffee is taken at that meal although this precaution may be unnecessary. The patient is kept at rest in bed, exercise is likely to produce a lower clearance value if there is already some renal impairment although it has little effect when the function is good. He is given 1,000 c c of water to drink in order to try to obtain the maximum clearance value which is probably more accurate than the standard clearance. The bladder is emptied and the specimen discarded. Shortly before the end of the first hour blood is taken for the blood urea estimation, and at the end of the hour the bladder is emptied. The duration of the period need not be one hour provided the exact time is noted, the volume of urine is measured and the amount of urea in it estimated. The bladder is emptied again at the

end of a second hour and the same estimations carried out on the urine This is an example from an actual case (Riches and Robertson 1935) —

H J aged 49	Diagnosis=Carcinoma of kidney
10 10 02 a m	Catheterized and bladder emptied Specimen discarded
10 55	Bled of 5 c c of blood
11 02	Bladder emptied by catheter (Specimen 1)
12 02	Bladder emptied by catheter (Specimen 2) Blood urea=30 mg per 100 c c

*First hour*—Urinary urea=0.4 gm per cent =400 mg per cent  
Urine volume=160 c c per hour (2.66 c c per minute)

$$\begin{aligned}\text{Maximum Clearance (Cm)} &= \frac{U}{B} \times V \\ &= \frac{400}{30} \times 2.66 = 35.5 \text{ c c}\end{aligned}$$

Normal is 75 c c

$$\text{Percentage of normal} = \frac{35.5}{75} \times 100 = 47 \text{ per cent of normal}$$

*Second hour*—Urinary urea=0.6 gm per cent =600 mg per cent  
Urine vol =92 c c per hour (1.53 c c per minute)

$$\begin{aligned}\text{Standard Clearance (Cs)} &= \frac{U}{B} \times \sqrt{V} \\ &= \frac{600}{30} \times \sqrt{1.53} \\ &= \frac{600}{30} \times 1.24 = 24.0 \text{ c c}\end{aligned}$$

Normal is 54 c c

$$\text{Percentage of normal} = \frac{24}{54} \times 100 = 44 \text{ per cent of normal}$$

$$\text{Mean} = 45.5 \text{ per cent}$$

This patient's renal function was only 46 per cent of normal. A disagreement of 10 per cent between the two hour results calls for a repetition of the test.

*Interpretation*—Even the healthy kidney shows wide variations in functional activity and variations in the urea clearance value are therefore to be expected. In general it may be said that when the clearance is 75 per cent the renal function is normal. Between 50 and 75 per cent it is doubtful. Below 50 per cent there is impairment and below 20 per cent renal insufficiency with a raised blood urea. Below 5 per cent there will almost certainly be uraemic symptoms. In surgical urology the test has its greatest value in cases of prostatic obstruction and a clearance of 55 to 60 per cent is probably the lowest limit of safety for a one-stage operation. In renal lesions such as tuberculosis or hydronephrosis a clearance below normal may rise after the removal of the diseased kidney, and a clearance value of 100 per cent be attained with only one kidney. Infection depresses renal function and this fact is well brought out by estimations of the urea clearance before and after treatment. It has been claimed by Van Slyke (1930) that the urea clearance test registers a fall in renal function some weeks or months before the phenol sulphone

phthalein excretion does and in general it is a more delicate indicator of renal impairment than the others. It does not depend upon the excretion of a foreign substance but shows the working power of the kidney under normal physiological conditions.

**D Radiographic tests—EXCRETION UROGRAPHY**—The introduction of substances which are excreted by the kidney and are radio-opaque has added a new method of study of renal physiology and anatomy, and has provided another variety of concentration or elumination test of renal function. The two organic iodine compounds most used are Iodoxy and Diodone. Both are issued in ampoules containing 20 cc of a stable sterile solution for slow intravenous injection.

**Iodoxy** (Syn Uroselectan B, Uropac, Pyelectan, Pyelumbrine, Neo-*io*παρ)—Contains 51.5 per cent of iodine and has a molecular weight of 493. The ampoule issued contains a dose of 15 gm in a 75 per cent solution. By virtue of the addition of invert sugar it is hypertonic and has a diuretic effect

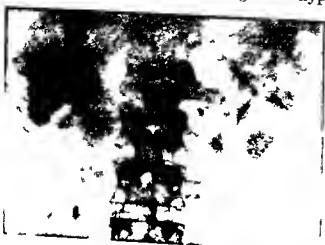


Fig 12

Excretion Urography as a test of Renal Function  
4" min film. Right ureteric calculus. Delayed filling  
and emptying on the right. Normal emptying on the left.  
(A. Raj, J. Dr. R. L. O. Donoghue)

for the first fifteen minutes after injection, the highest concentration of the drug in the urine is in the second fifteen minutes. It is completely filterable from the plasma and is excreted by the tubules. It is excreted unchanged in the urine 30 per cent being eliminated in the first hour and 63 per cent in eight hours. The best radiographic shadow is given in the kidneys in ten to thirty minutes after injection.

**Diodone** (Syn Perabrodil, Uriodone, Pyelosil, Diodrast, Neo skiodan)—Contains 49.8 per cent of iodine and has a molecular weight of 508. The dose for an adult is 7 gm in 35 per cent solution. It is probably even less toxic than Iodoxy and can if necessary be given by subcutaneous or intramuscular injection. (For the former it should be diluted with twice its volume of distilled water.) It is excreted unchanged by the urine, 60 per cent being eliminated in seven to nine hours. The best radiographic shadow is given in eight to twelve minutes after injection, so that it is a little more rapid than Iodoxy.

These substances should not be given when there is marked renal insufficiency and in cases of doubt a blood urea estimation should be done first.

The interpretation of renal function by excretion urography depends mainly on the radiographic appearance of the shadow and to a lesser extent on tests of elimination in the urine and retention in the blood.

**1 RADIOGRAPHY—Normal findings**—The time of appearance is important. Normally the shadow of the pelvis should appear in from four to eight minutes, it is preceded by an indefinite shadow of the whole kidney substance. The shadow of the pelvis has disappeared almost completely in about an hour. The density of the shadow gives an indication of the power of concentration.



tration of the kidney, due allowance being made for obesity and variations in radiological technique

The shape of the pelvis and calyces shows whether the kidney is anatomically normal

In renal impairment the time of the appearance of the shadow is delayed and excretion prolonged with a less dense shadow than the normal. If however, there is ureteric obstruction the shadow on the diseased side may be denser than that on the sound side, its time of appearance may be normal but there will be delayed emptying. Fig 12 shows the delayed filling and dilatation

of the right pelvis in a case of right ureteric calculus. The left pelvis is nearly empty at forty five minutes whilst the concentration of the dye on the right side was still increasing. Fig 13 shows the same case seven weeks after removal of the stone. There is still a little dilatation on the right but the concentration



FIG 13

Same case as Fig 12 seven weeks after removal of right ureteric calculus. 2 min film. Equal concentration right and left. (X ray by Dr F H Kemp)



FIG 14

Excretion Urography as a test of Renal Function. 45 min film. Prostatic obstruction two weeks after suprapubic catheterization for chronic retention. Poor concentration and dilatation on both sides. (X ray by Dr R L O Donoghue)

on the two sides is about equal. If only one kidney is impaired the good one may excrete all the drug and nothing may appear at all on the diseased side but if both are impaired there will be poor concentration and delay perhaps of several hours before shadows appear. Fig 14 shows the excretion urogram of a patient undergoing suprapubic drainage for chronic retention due to prostatic obstruction. The blood urea had fallen from 84 mg to 50 mg per 100 cc after two weeks drainage. The kidneys showed only a faint shadow at fifteen minutes and poor concentration with dilatation at forty five minutes. In this case the excretion urogram was the deciding factor in delaying operation on the prostate for a further three weeks by which time indigo carmine was excreted at six and a half minutes and the blood urea had fallen to 30 mg per 100 cc.

**2 RADIOGRAPHY OF THE URINE** passed at successive intervals after the injection will show the power of concentration from the varying depth of shadow.

**3 THE SPECIFIC GRAVITY** of the urine rises in the first hour to 1050 or more, to

correct for the accompanying polyuria it has been suggested that a 'function index' obtained by multiplying the amount of urine in cubic centimetres by the last two figures of the specific gravity should be used

4 ESTIMATION OF THE DRUG IN THE URINE—Iodoxyl can be precipitated from the urine by adding one part of concentrated hydrochloric acid to four parts of urine the precipitate is dried and weighed. In a normal case the maximum excretion is between one and a half and three hours after injection. This method has been used as the basis of a test of renal function (Wade and Band 1930)

5 ESTIMATION OF THE DRUG IN THE BLOOD—Iodoxyl should be completely eliminated from the blood in four hours retention of 0.5 gm after this time has been held to show minor renal impairment greater amounts indicate more serious damage

The value of tests 2 3 4 and 5 is doubtful as the same information can be obtained more easily by other means. The radiographic demonstration of a functioning kidney however can be of great value particularly in a case of renal injury on the other side where exploration may lead to nephrectomy

The choice of renal function tests—The selection of suitable tests for a particular case depends to a considerable extent on the nature of the disease. In surgical renal lesions the urologist is more interested in the function of each kidney separately whilst in obstructive and neurogenic disease of the lower urinary tract he is concerned with the total renal function. The study of individual renal function can be made by the indigo carmine test or by excretion urography without the use of ureteric catheters. The passage of a ureteric catheter introduces certain fallacies it may cause a temporary cessation or diminution of secretion on that side and unless it is large enough to fit the ureter closely there will be leakage around it and some urine will be lost into the bladder. Moreover the retention of a ureteric catheter for two or three hours is undesirable. Nevertheless some of the other tests can be used in this way if due regard is paid to these sources of error. The test of fluid intake and output the urea concentration test the phenol sulphone phthalein test and the urea clearance test are examples

If the total renal function is being investigated as in a case of prostatic obstruction there is a wider choice available all the tests described being suitable under different conditions. One must consider the *accuracy* of the test its *convenience* and its *safety*. The most *accurate* is probably the urea clearance test which includes an estimation of the blood urea approaching it is the urea concentration test if combined with a blood urea estimation. Both of these tests require the use of a urethral catheter in a prostatic case and neither is likely to be accurate if there is much urinary infection especially if the bladder urine contains *B. proteus* or other urea splitting organism. In a patient who has had prolonged suprapubic drainage it is difficult to obtain a satisfactory result with either test. The indigo carmine test alone when observed cystoscopically has a degree of accuracy out of all proportion to its simplicity and even without cystoscopy its accuracy is not to be despised. The late Harry Harris carried a blue glass stopper which he used as a colour standard for the ten minute concentration of indigo carmine in cases awaiting prostatectomy.

For *convenience* the blood urea and indigo carmine tests are unrivalled. The former determination should be made at the outset in almost every case a normal value may be obtained even if there is some renal impairment but a raised figure on a normal diet and in the absence of vomiting diarrhoea or gross circulatory weakness is an indication of renal insufficiency. The

chemical estimation can be made rapidly in a good laboratory and under peace time conditions there is little delay in getting the result back

The indigo carmine test has the further advantage that it can be carried out by the clinician himself at the time of cystoscopy or as a routine interval test in the ward. No laboratory determination is needed and the time spent on obtaining the result is only measured by the degree of functional impairment of the kidneys.

The specific gravity test is also easily carried out but it involves the deprivation of fluids for some hours from a patient who is in need of them.

The safety factor need only be considered seriously when there is renal insufficiency and this should have been discovered by the blood urea determination. In other words the blood urea is the safest test of all. It is unwise to introduce foreign substances into the blood stream when there is marked renal insufficiency and this rules out the dye tests including excretion urography when the blood urea is much raised. It is impossible to lay down a specific figure for the safety level but I would hesitate to do an excretion urogram with a blood urea of more than 100 mg per cent. Severe infection, advanced cardiovascular disease, hepatic insufficiency, hyperthyroidism, allergic states and a known hypersensitivity to iodine are also contraindications.

Safety from the introduction of infection must also be remembered: the urea clearance, the urea concentration and the phenol sulphone phthalein tests require either intermittent catheterization or an indwelling catheter for two or three hours and the surgeon must be certain that proper asepsis is maintained throughout the test.

To summarize it is better to rely on the results of at least two tests, one of elimination and one of retention, combined with an estimate of the clinical state of the patient before presuming to assess his renal function. There is no satisfactory test of the reserve power of the kidneys which is normally high. Familiarity with particular tests has the added advantage of giving experience in their interpretation and no well tried test should be discarded lightly. Our own preference is for a blood urea test in every case combined with an excretion urogram in renal lesions and a urea clearance test in lower tract lesions. Both the indigo carmine test and excretion urography play a useful part in cases of prostatic obstruction.

E. W. RICHES

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## CHAPTER IV

### EXAMINATION OF THE KIDNEYS

#### CLINICAL INVESTIGATION

**I**NSPECTION may reveal an anterior bulge in one or both loins in the case of a large renal neoplasm hydronephrosis solitary renal cyst or polycystic disease of the kidneys. Eversion of the lower ribs may be visible as in a case of large left hypernephroma which was subsequently removed.

*Palpation* which should always be performed with warm hands detects tenderness rigidity a lump or oedema in the loin both anteriorly and posteriorly. In feeling for the right kidney the left thumb presses backwards from in front and the other fingers press forward from behind the right hand is similarly used for the left kidney.

In a big or fat patient the bimanual method is better the left hand being used to push forward the right kidney while the right hand placed below the ribs sinks deeper at the end of every expiration. The role of the hands is reversed for the left kidney. The fingers should be placed flat on the surface and pressure gently increased sudden poking movements of the finger tips should be avoided. Palpation is facilitated if the patient draws up the knees and breathes through the mouth.

*Percussion* reveals an impaired or dull note over a renal tumour large enough to push aside the intestines. Otherwise there is anterior resonance not always easy to define as a classical band but often in marked distinction from an enlarged spleen or gall bladder which usually hugs the anterior abdominal wall with consequent overlying dullness.

Auscultation does not play much part in clinical renal examination.

A kidney tumour presents in the loin or is capable of being pushed there and moves on respiration unlike a perinephric abscess or retroperitoneal sarcoma. It is said that there is no always or never in medicine and I have met a large perinephric abscess and a large retroperitoneal sarcoma whose mobility on respiration led to my thinking them respectively a pyonephrosis and a renal neoplasm.

The two sides here as elsewhere when possible should be compared. Bilateral tumours may be polycystic kidneys or hydro- or pyonephroses or rarely renal neoplasms.

In a thin patient it is common to be able to feel the lower right renal pole at the end of full inspiration (palpable kidney). The second degree of mobility in which at the end of inspiration the observer's hand can feel the upper renal pole and prevent it from retreating under the ribs on expiration entitles the kidney to be illogically called a movable one illogically since all kidneys move. The third degree of mobility is that in which a kidney can be placed in the opposite iliac fossa (floating kidney). I have not yet observed this degree of mobility.

#### RENAL RADIOGRAPHY

Plain X-ray films often show the position and outline of the kidneys and the presence of opacities within these outlines in the anterior film. Should

these opacities represent calcified mesenteric glands or gallstones they will be found lying anterior to the vertebral column in lateral views whereas renal calculi usually overlie it except in the case of a greatly dilated or misplaced kidney

**RENAL OPACITIES**—These are usually due to stones or calcified tuberculous renal cysts simple or hydatid also may show calcification I have no personal experience of such but I have met with many renal neoplasms which showed calcification sometimes in the periphery of the mass sometimes irregularly dispersed throughout it in trabecular fashion and sometimes present in a particular area of the tumour in a peculiar stippled pattern Three out of five neoplasms seen in one year showed calcification which it is not generally realized is quite consistent with a diagnosis of neoplasm The view has been expressed that calcification in a neoplasm is an index of greater malignancy I or others with whom I agree calcification is a symbol of chronicity and of low malignancy One patient from whom was removed an extensively calcified hypernephroma known to have been present for over five years together with a hypernephromatous lymph gland is free from evidence of recurrence three years after operation (Fig 56)

A stone in the renal pelvis is usually of triangular shape with a beak presenting at the ureteropelvic junction Lateral extensions into the calyces give the staghorn shadow When multiple kidney stones are present the further apart they lie the more disorganized is the kidney (Fig 69) Contrary to the statements in some books that cystin stones throw poor or no shadows cystin stones throw good shadows (For further details see p 906)

A PERITONEAL ABSCESS often associated with renal disease usually leads to raising of the diaphragm on the affected side obscuration of the psoas shadow and convexity of the lumbar spine towards the corresponding kidney

Intravenous urography, by means of injection of various opaque dyes of which uroselectan is the best known outlines the urinary tract pictures being conveniently taken five fifteen and thirty minutes after injection As regards pyelography by the only path formerly available namely the upward route usually by way of ureteric catheters this is often called the retrograde method in contrast with the intravenous route (occasionally with incompetent uretero-vesical junctions cystography by filling the bladder from below results in the renal pelvis also being demonstrated) However since the downward passage of urethral instruments through the opened bladder is also called retrograde it seems inconsistent to apply the same term to upward pyelography The name ascending pyelography in contrast with intravenous or descending pyelography is free from this objection

Among the advantages of intravenous urography as opposed to ascending pyelography are that it is available when cystoscopy or ureteric catheterization is impossible or undesirable both sides (Figs 15 to 18) as also the bladder are simultaneously outlined a physiological demonstration of the urinary tract undistorted by instruments and distension is obtained and if correctly interpreted the pictures give valuable information as to renal function

Absence of a renal shadow in the usual time does not necessarily mean an absent or functionless kidney it may also indicate a poor function kidney with delayed appearance of shadow or a good function kidney temporarily put out of action as by a small obstructing stone Before performing nephrectomy normality in size and shape of renal outlines visualized five minutes after injection of uroselectan is a valuable rival of other differential tests of renal function and so far my experience is that confidence in it as the sole such pre nephrectomy test is safe

X ray pictures after injection of uroselectan may also provide a rough measure of the amount of residual urine after micturition and thus act as an alternative method to suprapubic percussion or urethral catheterization



FIG 15

Intravenous pyelograms showing normal appearances



FIG 16

Intravenous pyelograms showing normal outlines of kidneys and kinking in the upper part of one ureter

The main contraindication to injection of uroselectan is a high blood urea or other evidence of gross total renal deficiency

Since one of the main advantages of intravenous urography is its physiological representation of the urinary tract undistorted by instruments or artificial distension it is undesirable to obstruct the ureters as by strapping a cushion over them, a practice sometimes recommended in order to increase the density of the shadow or the sharpness of its outlines or to achieve complete

filling of the pelvi-calycal system—advantages belonging to ascending pyelography.

With regard to the differential value of, and indications for, uroselectan

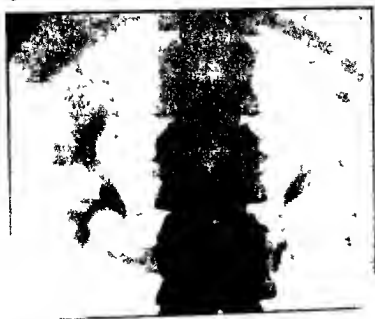


FIG 17

Intravenous pyelograms showing somewhat elongated calyces on the left side



FIG 18

Intravenous pyelograms showing normal outlines

and ascending pyelography, it is impossible to dogmatize, especially as these methods of investigation are complementary and not antagonistic. Each has its field of usefulness, and these fields partially overlap.

Intravenous urography is, perhaps, most usefully employed to obtain a preliminary general view of the urinary tract (Figs 17 and 18), ascending pyelography

being reserved to elucidate if possible, any surviving obscurity. It is certain that descending pyelography has greatly curtailed the need for ascending pyelography, even in the most important provinces of hæmaturia and suspected renal neoplasm. For instance in five consecutive cases of renal neoplasm seen by me in 1936 the intravenous pyelograms by themselves, and without the aid of ascending pyelography, were sufficient, in conjunction with the clinico-cystoscopic findings, to establish the diagnosis. The withholding of ascending pyelography in such cases may be desirable in avoiding possible neoplastic dissemination in view of the cases where such dissemination has followed rapidly on the performance of ascending pyelography. However, when the uroselectan findings are inconclusive ascending pyelography remains as the final and imperative pre operative court of diagnostic appeal in all cases of renal hæmaturia and suspected renal neoplasm.

Again, in cases of suspected renal carbuncle and in cases of perinephric abscess, which may be secondary to a renal carbuncle, uroselectan pyelography is valuable in suggesting renal innocence or involvement, the uroselectan pyclogram of renal carbuncle being somewhat similar to that of renal neoplasm—filling defects or non-visualization of some of the calyces or pelvis. Unlike renal neoplasm however, renal carbuncle is associated with pyrexia, flushed face, loin tenderness and leucocytosis, while hæmaturia is absent.

### CYSTOSCOPY

Cystoscopy is, perhaps, the most important special method of investigation in urology, and furnishes the key to a large number of urinary problems. Inspection of the ureteric orifices may give important clues as to renal disease. For instance, a pink puffy ureteric orifice is often the vesical symbol of pyelitis, tubercles at or near the orifice, or a gaping, ulcerated, or retracted orifice, probably point to renal tuberculosis of that side, bullous oedema of the orifice may conceal a stone that has descended from the kidney, or the stone may actually be seen presenting into the bladder, while a second ragged apparent ureteric orifice, above and lateral to the normal one may signify former ulceration into the bladder of a ureteric stone that did not succeed in reaching and traversing the ureteric orifice. On the other hand, a normal-looking second ureteric orifice may give the clue to renal pain, especially when the hydronephrotic half of a double pelvis has failed to be demonstrated by uroselectan pyclography. Of two such ureteric orifices communicating with a double renal pelvis, the lower and inner orifice corresponds to the upper pelvis.

Again, a pin hole ureteric orifice, or a bulging ureteroceles, will suggest dilatation of the urinary tract above it—hydroureter or hydronephrosis, or both, while loin pain may find its explanation in a bladder growth (usually a malignant one) which obstructs the ureteric orifice.

The renal possibilities implied in turbid, frankly purulent or bloody ureteric effluxes are obvious. Other lesions favouring the neighbourhood of the ureteric orifices, and having possible renal repercussions, are vesical papillomata, diverticula, and bilharziasis with its golden nodules.

The main contraindications to cystoscopy are few—acute urinary infections, acute retention of urine, chronic vesical distension, and renal failure. On the other hand its indications are many. Excluding affections which involve the bladder primarily, one may note the following renal symptoms and conditions in which cystoscopy is useful —



(b) *Determination of the relation of the ureters to suspected shadows* by the use of radiographically opaque instruments. This indication for ureteric catheterization has been lessened but not abolished by the introduction of intravenous urography—lessened since urography may well demonstrate the ureter in relation to the shadow not abolished since urography may not reveal the desired portion of the ureter which is normally not demonstrated in its entire length by urography.

(c) *Ascending pyelo ureterography*—Here again the introduction of intravenous urography has lessened but not abolished the indications for ascending pyelography the two methods being really complementary. This subject is further considered below.

URETEPIC CATHETERIZATION IS USUALLY CONTRAINDICATED in the presence of a grossly infected bladder but if it is essential the ureteric catheters should be passed only an inch or two.

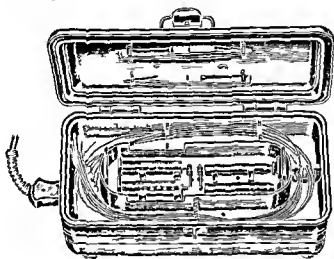


FIG. 19

Electrically heated formalin sterilizer for ureteric catheters (Wensbury  
Wales pattern) with tray forceps syringes etc. ready for use.

With regard to the STERILIZATION OF URETERIC CATHETERS the following is a typical method of dealing with them after use. First they are washed and syringed through with sterile water. Secondly they are hung up to drain and dry for twenty-four hours and thirdly they are exposed to formalin vapour for another twenty-four hours. The sufficient sterilization of the catheters by this method being evidenced by its safety as personally experienced over a period of twenty years.

With regard to the sterilization of ureteric catheters with stilettes in position the possible objection that points of contact of stilette and catheter might not be accessible to the formalin vapour is probably mainly academic. Against this is the advantage that the lumen of the catheter is thus proved free—a freedom which otherwise requires proof by syringing fluid through it. If this were not possible (an uncommon event) the use of a stilette might still be required.

However, since it is in any case desirable to syringe fluid through ureteric catheters immediately before use in order to abolish air locks and to disperse formalin vapour which might otherwise interfere with organismal growth the sterilization of ureteric catheters with or without stilettes in position seems largely a matter of personal preference (Figs 19 and 20).

In Joly's electric sterilizer for ureteric catheters hot concentrated formalin vapour is pumped through these returning around them in the rubber tubes in which the catheters are encased. Sterilization is achieved within half an hour.

In the absence of Joly's apparatus should ureteric catheters not previously sterilized by formalin be quickly required an alternative method of sterilization consists in soaking them in a solution of 1 in 4000 mercury per chloride for half an hour.

**Ascending pyelography**—Before considering the question of pyelography and the interpretation of the pictures obtained it is desirable to have a general idea of the position and size of the normal renal pelvis and to realize the existence of its normal varieties.

With the patient lying down the normal pyelogram appears below the ribs and lateral to the upper two or three lumbar vertebrae the true renal

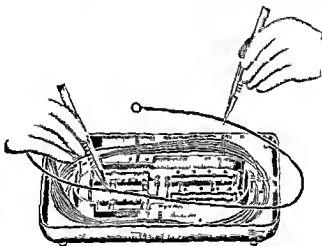


FIG. 20

With tray removed from sterilizer showing method of selecting catheter or electrode without disturbing remainder

pelvis lying opposite and close to the second and third lumbar transverse processes so that a horizontal line bisecting the pelvis is often level with the second lumbar intervertebral disc. However the true pelvis is often level with the first and second lumbar vertebrae. The upper calyx reaches towards or up to or across the twelfth rib and occasionally across the eleventh. The right renal pelvis usually lies about an inch lower than the left. Although the normal limits are thus elastic one may class as abnormal a position of the renal pelvis below the level of the third lumbar vertebra.

The average capacity of the renal pelvis is about 7 c.c. but as much as 20 c.c. may still be considered normal while 30 c.c. may be taken to indicate moderate dilatation.

The normal renal pelvis is roughly triangular or trumpet shaped the lower margin of the pyelogram curves regularly and smoothly into the outer margin of the ureter and the pelvis tapers gradually into the ureter.

Usually three major calyces project laterally and anteriorly from the true pelvis but there may be only two the middle one frequently the smallest being rudimentary or absent when a branch from the lower major

calyx acts as a substitute. The absence or virtual absence, of a major calyx should be remembered as an occasional normal variation, and not necessarily a pathological sign. However the presence of only one major calyx usually denotes a renal lesion. Occasionally the major calyces may appear to be absent altogether, the minor calyces into which the major calyces usually subdivide appearing to sprout directly from the true pelvis. On the other hand, elongation of a major calyx, usually the upper one, is not infrequent. Such elongation may be regarded as being a developmental step towards reduplication of the pelvis which is described as partial when the second pelvis branches from the first and complete when it branches from the ureter. With a double pelvis the upper one is usually smaller and has fewer calyces. This congenital anomaly has been shown by pyelography to occur so frequently (in about 4 per cent. of cases) that it may almost be considered as a normal variant.

When seen "end-on," instead of projecting outwards from the true pelvis, a calyx forms a dark round area near the outer part of the pelvis, and may resemble a stone.

The true pelvis itself may be congenitally large, small, or even absent as a sac intervening between calyces and ureter.

It is well to remember these normal variations, some of which may simulate the appearances found in renal disease. One of the most important signs of a normal pyelogram is the presence of the terminal irregularities formed by the minor calyces, into which the renal papillæ project. In cases of doubt, comparison of the pyelograms of both sides is desirable, since individual variations are usually symmetrical.

THE MAIN INDICATIONS FOR ASCENDING PYELOGRAPHY are —1 Non medical hæmaturia (that is to say cases of hæmaturia free from such causes as purpura and leukaemia, or congestion, inflammation and embolism of the urinary tract) when there is no obvious cause, such as trauma, caruncle, or over-dosage with hexamine, especially painless hæmaturia, and particularly if unilateral,

2 Obscure abdominal pain especially recurring unilateral pain,

3 To demonstrate the relation of the renal pelvis and ureter to abdominal masses of uncertain diagnosis,

4 To demonstrate the relation of the renal pelvis and ureter to radiographic shadows of doubtful nature,

5 In the investigation of obscure cases of renal infection.

As already stated, the introduction of intravenous urography has diminished, but not abolished, these original indications for ascending pyelography, which, however, especially in cases of hæmaturia and suspected renal neoplasm, retains first place as the most important method of renal investigation, short of lumbar exploration. Many unnecessary operations are prevented by pyelography, on the other hand, when they are necessary, pyelography enables them to be undertaken with the most accurate information as to the conditions to be encountered.

THE MAIN CONTRAINDICATIONS TO ASCENDING PYELOGRAPHY are —

1 Acute inflammation in the urinary tract,

2 Severe chronic urinary sepsis,

3 Renal insufficiency,

4 Old age, emaciation and asthenia,

5 Instrumental supersensitiveness,

6 Ability to reach a diagnosis without ascending pyelography, especially in renal tuberculosis or neoplasm.

THE MAIN POINTS OF ASCENDING PYELOGRAPHIC TECHNIQUE are —

- 1 Absence of general anæsthesia
- 2 Low position of the patient's head
- 3 Experience in ureteric catheterization
- 4 Small size of the opaque ureteric catheter (No 5 French)
- 5 Withdrawal of the catheter for 1 cm if it has passed the full distance when it is commonly arrested in the upper calyx
- 6 Preliminary aspiration of the renal pelvic contents
- 7 Slow gentle injection of warm 12 per cent sodium iodide or bromide
- 8 Immediate cessation of injection at the first onset of loin pain
- 9 Immediate taking of the pyelogram on completion of injection
- 10 Immediate post pyelographic aspiration

In the absence of loin pain a preliminary picture should be taken after the injection of 7 to 10 c.c. as a gauge of the amount required for a second pyelogram should this prove necessary

POST ASCENDING PYELOGRAPHIC REACTIONS AND COMPLICATIONS include —

- 1 Pain
- 2 Reflex pallor faintness nausea and vomiting
- 3 Hæmaturia
- 4 Pyrexia and shivering
- 5 Iodism
- 6 Anuria
- 7 Renal necrosis
- 8 Renal rupture
- 9 Death

Apart from a minor degree of pain these complications may be avoided by suitable selection of patients and by strict adherence to the details of a correct technique

The differential value of descending and ascending pyelography has already been discussed. It may here be briefly repeated that these methods are largely complementary not mutually exclusive diagnostic aids each with its own often overlapping field of usefulness and that while uroselectan pyelography has rendered many ascending pyelograms unnecessary ascending pyelography retains its supreme importance in cases of renal hæmaturia and suspected renal neoplasm in which uroselectan urography has left the diagnosis doubtful

ALEX. E. ROCHE

## CHAPTER V

### ABNORMAL CONSTITUENTS OF THE URINE

#### URINANALYSIS

**R**OUTINE examination of the urine in cases of genito urinary disease should, in all cases include investigation of both its physical and chemical properties direct examination of the centrifuged deposit, and aerobic bacterial culture Lines of further examination may result from the findings in this preliminary examination, *i e* urine, sterile on aerobic culture, but containing numerous pus cells, must be examined for the bacillus of tuberculosis Remembering the necessity for urine culture and the fallacies which may arise during chemical and microscopic examination, the specimen should be collected with much care

**Collection of specimens of urine**—Providing a laboratory is at hand, convenient receptacles for the collection of urine are sterile plugged wide-bore test tubes If the specimens have to be sent some distance, sterile wide-mouthed screw cap bottles are more suitable

In the female, the urine should invariably be a catheter specimen obtained after due cleansing and the taking of aseptic precautions By this means, blood and protein from the menses, mucus and bacterial flora from the vagina and faecal contamination will be excluded An oily catheter lubricant should never be used

In the male, the glans penis and meatus, with retracted prepuce, should be cleansed, but not by the patient himself, and a first-stream urine, containing the contents of the anterior urethra, should be passed into a wide-mouthed sterile bottle or test tube A second, or "mid stream specimen," is then passed into another sterile bottle or tube This mid stream specimen is free from anterior urethral contamination and generally suffices for microscopic and bacteriological examination of the bladder contents Should phimosis be present, which precludes retraction of the prepuce, this method of collecting a specimen of urine is unsatisfactory and must be replaced by catheterization, as the urine may contain pus cells and organisms from a balanitis, or organisms of the acid fast smegma type

Finally a rectal examination should be carried out, the prostate and seminal vesicles massaged, and the patient told to pass the rest of his water into a third sterile bottle or test tube These specimens should be labelled "anterior urine," "posterior urine" (or mid-stream specimen) and "urine after massage"

**Physical examination**—Much information can be gained of the physical characters of the urine from inspection and, for this reason, a sample should be retained in the consulting room or hospital ward in a conical urine glass for examination The first thing to be observed is the presence or absence of a cloud and, if present, whether it is in the urine when voided or whether it develops on standing A phosphatic cloud is increased by heating and disappears on the addition of acetic acid A cloud due to urates increases on cooling, is unaffected by acid, and disappears on heating Turbidity which remains after heating or after the addition of acid indicates the presence of mucus or muco-pus

The presence of a cloud of phosphates in the urine, when freshly passed, is an important diagnostic point as it may account for a variety of symptoms

varying from renal colic to urethral pain and even urethral discharge. Other points readily observed are excessive quantities of mucus, the presence of blood or bile in quantity and the character of crystalline and other deposits. A pale urine of high specific gravity is highly suggestive of glycosuria while one of low specific gravity especially if persistent and with the patient on a normal diet and fluid intake suggests renal deficiency which must be confirmed by renal function tests or possibly diabetes insipidus.

**Chemical examination—REACTION OF THE URINE—**For ordinary purposes litmus paper will give a reasonably accurate indication of the acidity or alkalinity of the urine and is sufficient to indicate the nature of certain of the urinary deposits. For example uric acid crystals, deposits of sodium urate and crystals of cystine are found in acid urines while deposits of ammonium urate and of phosphates occur in alkaline urines.

If more accurate information is required such as in the control of cases being treated with mandelic acid various dye indicators are used to determine the reaction of the urine in terms of pH. Bromothymol blue for example is yellow in acid solution of pH 6.0 and changes through green at neutral at pH 7.0 to deep blue at pH 7.6. For accurate estimations over a wide pH range several indicators are required with colour standards for each indicator but the technique is very simple. A preliminary rough estimate of the reaction may be made by using a B.D.H. (British Drug Houses) Universal Indicator which covers the range of pH 4.0 to pH 11.0 the final estimate being made by the appropriate indicator. A suitable selection of indicators to cover the pH in urine is as follows—

Methyl red	pH range 4.4 to 6.0
Bromocresol purple	5.2 to 6.8
Bromothymol blue	6.0 to 7.6
Phenol red	6.8 to 8.4

A satisfactory colorimeter for this purpose is the Lovibond Comparator with which are used discs fitted with permanent glass standards for each indicator the pH values rising in steps of 0.2.

**PROTEINURIA—**The commonest proteins in the urine are mucus, serum albumin and globulin and haemoglobin. Mucus though normally present commonly appears in excess in inflammatory conditions of the urinary tract. In acid urine it settles out as a cloud on standing and is precipitated in the cold by acetic acid in alkaline urines in which it is soluble. It must be remembered that the action of heat on serum proteins is dependent on the pH of the urine. In alkaline solution especially on heating protein is converted into metaprotein which does not coagulate on boiling. Before the boiling test is performed therefore the reaction of the urine should be tested with litmus paper as otherwise quite considerable amounts of protein may be missed unless an alkaline urine is made acid to litmus with acetic acid before boiling. Mucus in solution is also precipitated by acidification.

A clean test tube is filled three quarters full with clear urine (filtered if necessary) and the top inch boiled. If after the addition of acetic acid a coagulum remains the test is positive for protein whereas a cloud which dissolves in acid is due to phosphates. Bence-Jones protein which appears on moderate heating and disappears on boiling is almost pathognomonic of myelomatosis. Frequently small amounts of protein may be of seminal origin as shown by the presence of spermatozoa in the centrifuged deposit. Postural albuminuria is eliminated by examining a specimen of urine which is passed by the patient before getting out of bed in the morning.

**BLOOD AND ITS DERIVATIVES IN THE URINE**—When blood is present in any quantity in the urine it is readily recognized macroscopically, and even small amounts can be identified in this way in the centrifuged deposit. For the determination of red blood cells especially when present in small numbers, microscopic examination is necessary for their identification. Haemoglobin and methaemoglobin in the urine are best recognized by centrifuging and examining the supernatant fluid spectroscopically.

The guaiac test is not of much value for the detection of blood, owing to its insensitivity and its many fallacies. A good chemical test for blood and haemoglobin in high dilution is the reduced phenolphthalein test in which Kastle Meyer reagent is used and which is made up as follows:

2 gm of phenolphthalein and 20 gm of potassium hydroxide are dissolved in 100 ml of distilled water. About 10 gm of zinc dust are added and the solution boiled until the pink colour disappears. After filtration it is made up to 100 ml and a particle of zinc dust added. The reagent does not keep very well.

To about 5 ml of this reagent add a few drops of 10 vol  $H_2O_2$  and 5 ml of urine and mix. The presence of blood or haemoglobin is shown by a pink colour. The haemoglobin acts as a carrier of oxygen from the hydrogen peroxide to the reduced phenolphthalein. This is oxidized to phenolphthalein, which immediately turns pink in the presence of the strong alkali.

**REDUCING SUBSTANCES**—Benedict's reagent is preferable to Fehling's as the latter does not keep well and if boiled excessively is reduced by substances such as uric acid which are normally present in the urine.

To 5 ml of Benedict's reagent add eight drops of urine and boil for two minutes. A red or yellow precipitate indicates the presence of a reducing substance. Where positive the presence of glucose should be confirmed by the fermentation test and the urine examined for acetone and acetoacetic acid using Rothera's test with ammonium sulphate and sodium nitroprusside, and Gerhardt's ferric chloride test. The discovery of a symptomless glycosuria always calls for a glucose tolerance test in order to estimate the level of the renal threshold and to exclude diabetes.

**BILE**—When the urine is dark in colour, or obviously contains bile, the presence of bilirubin may be confirmed by the use of the ring test with concentrated nitric acid or with tincture of iodine.

**THE CENTRIFUGED DEPOSIT**—The centrifuged deposit should in every case be examined microscopically by placing a drop of it under a cover slip and examining it wet. For the further study of cellular elements and of organisms, examination of dried and stained smears may be necessary. The interpretation of the findings depends on whether the specimen is a "mid stream" or the "urine after prostatic massage". Substances found in urinary deposits include casts (cellular, granular or hyaline), cellular elements (red blood corpuscles, leucocytes, epithelial cells and spermatozoa), crystalline or amorphous deposits, parasites and extraneous material.

A careful search must be made for casts in all cases of proteinuria. As a general rule the combination of casts and protein in the urine indicates a nephritis but when the protein is scanty or intermittent and the casts are of the hyaline or granular variety, the differential diagnosis between a true nephritis and a localized focus of little significance in the kidney depends on clinical investigation.

It is a matter of some importance to identify the cellular content of a urinary deposit as for example, the diagnosis of renal colic may be confirmed by the finding of small numbers of red blood corpuscles. Red blood cells are usually easily recognizable by their pale straw colour and typical outline,

especially if crenated cells are present. Some confusion may arise if biscuit shaped calcium oxalate crystals, amorphous urates and contaminating yeast cells are seen, but these are readily distinguishable on closer scrutiny. The presence of red cells may be obscured by a heavy deposit of pus. In this case a drop of methylene blue is placed at one edge of a cover slip and a fragment of blotting paper along the opposite edge. Pus and epithelial cells readily take up the methylene blue while any red cells present become easily recognizable as they remain unstained.

Although this wet staining method is a useful adjunct in the detailed examination of pus cells and the various types of epithelial cells sufficient information will usually have been obtained by direct examination. As has been stated both pus cells and also the large epithelial cells are readily recognizable.

Spermatozoa are easily recognized and if present may account for small amounts of protein.

**The crystalline deposits—PHOSPHATES—**Phosphates may occur either as amorphous calcium phosphate or in crystalline form. The commonest crystals are triple phosphates (ammonium magnesium phosphate) which occur in alkaline urine. Less commonly stellar phosphates (calcium hydrogen phosphate) may be found in a slightly acid urine. It is important to recognize the presence of phosphaturia especially if the phosphates are in suspension when the urine is passed as it may be the result of mental worry or strain and cause very real symptoms which will rapidly clear up by change in the pH of the urine to the acid side. (See Phosphaturia p. 57.)

**CYSTINE—**Although cystine crystals in the urine are uncommon it is important to recognize them as they are associated with a marked liability to calculus formation. The crystals are colourless hexagons and are deposited only in an acid urine and so may be missed if the urine is alkaline in which case it should be acidified and left to stand half an hour and then centrifuged. Crystals of uric acid which sometimes occur in hexagonal form may be confused with cystine although the former are usually coloured yellow by urinary pigments. Cystine being soluble in mineral acids can be distinguished from uric acid which is insoluble by the addition of 30 per cent hydrochloric acid to the preparation under the microscope. The crystals of cystine disappear but those of uric acid remain unchanged.

**CALCIUM OXALATE—**Calcium oxalate occurs in the form of typical envelope crystals or as dumb bell or biscuit shapes. Their identification in the urine is a matter of importance because if present they are capable of causing hæmaturia.

**URIC ACID CRYSTALS AND URATES—**Uric acid crystals are found in a multiplicity of crystalline forms and occur in an acid urine on cooling. They are usually of a yellowish colour from adsorption of urinary pigments and aggregates may be visible to the naked eye as the so called cayenne pepper deposit. In the same way amorphous deposits of urates readily adsorb the urinary pigments appear on cooling and redissolve on heating and are found in acid urines. Crystalline urates occur as sodium urate and ammonium urate the latter being found in an alkaline urine.

**SULPHONAMIDE CRYSTALS—**These may be found in the urine of a patient undergoing sulphonamide therapy. Their appearance may differ considerably from the simple rhomboid or trapezoid forms obtained by crystallization of the pure substance in water.

**PARASITES—**Though rare in this country the commonest parasite found in the urine is the egg of *Schistosoma hæmatobium*. It is a frequent cause of hæmaturia in the Near East and may occur in patients returning from overseas. The terminal spined ovum of *S. hæmatobium* may be found in the



"end-of stream urine but is best looked for in the last drops of urine expressed by prostatic massage

### BACTERIOLOGICAL EXAMINATION OF THE URINE

Bacteriological examination of the urine should include aerobic culture of the 'mid stream specimen' in the male or the "catheter specimen" in the female. One ml. of the urine is either spread on the surface of an agar plate or in a poured plate. This same method is also useful for estimating the results of treatment. The commonest organisms found are those of the *Bact. coli* group. Other organisms in order of frequency, include streptococci, staphylococci, *proteus vulgaris* and *pseudomonas pyocyanea*. Although the *Bact. coli* is usually found in pure culture, mixed infections may occur.

If a pure infection by the *Bact. coli* or the streptococcus is present, the urine is acid, but undergoes ammoniacal decomposition in the presence of the staphylococcus or the *proteus vulgaris*.

If the urine contains pus cells but is sterile on culture, smears must always be examined for *B. tuberculosis*. (See p. 803.)

### HÆMOGLOBINURIA

Hæmoglobinuria consists of the passage of oxyhæmoglobin or methæmoglobin in the urine. It is the result of hæmolytic and is pre-renal in origin. It can be caused by various poisons, such as carbolic acid or potassium chlorate, and may be present in systemic infections such as blackwater, typhoid and certain other fevers or may follow the injection of foreign sera or an incompatible blood transfusion. It is sometimes noted after severe burns and in some crush injuries and may occur in the new born in conjunction with jaundice (Winkel's disease).

Paroxysmal hæmoglobinuria is a condition which is confined mainly to adult males and may be associated with congenital syphilis. Attacks, rarely more than twenty-four hours in duration, are often accompanied by vomiting and preceded by chills and fever.

Hæmoglobinuria is distinguished from hæmaturia spectroscopically as has been described. It must also be distinguished from the reddish discoloration of the urine after certain drugs such as pyridium and foods such as beetroot.

**Treatment**—The treatment is not urological and consists in dealing, as far as possible with the causal condition. In severe cases, blood transfusion may be necessary. In paroxysmal hæmoglobinuria anti-syphilitic treatment is indicated especially if the Wassermann test is positive.

### HÆMATURIA

Hæmaturia consists of the passage of blood in the urine which means, either that bleeding is going on in some part of the urinary tract, or, that blood is being excreted by the kidney as a result of certain general diseases, such as purpura or arteriosclerosis or of certain drugs or poisons.

Hæmaturia is merely a symptom and may be due to a variety of causes such as trauma, new growth, inflammation, congestion or stone. It may occur alone (symptomless) or be accompanied by other urinary symptoms such as pain, of either upper or lower urinary tract type or by frequency of micturition. When occurring with other symptoms it must always be assessed in conjunction with these in order to arrive at a provisional diagnosis. For example, terminal hæmaturia, frequency of micturition, and pain at the end of micturition suggest a vesical calculus if the urine is clear or cystitis if

pyuria is present. Symptomless hæmaturia is characteristic of a new growth and thus it is of vital importance that no time should be lost in carrying out a complete urological investigation either to establish or to exclude its presence. Bleeding is unfortunately not an early symptom of a neoplasm as the latter may be present for many months and sometimes for years before ulceration with erosion of blood vessels occurs.

In both painless and painful varieties of hæmaturia the blood may appear at the beginning or the end of micturition or may be intimately mixed with the urine and this relationship is a useful guide to its site of origin. Urethral bleeding causes initial hæmaturia and if of the painless variety calls for urethroscopy. Painful initial hæmaturia such as may occur in gonococcal urethritis does not present any great difficulties in diagnosis even though instrumentation is contraindicated.

Terminal hæmaturia points to an intravesical cause. If painless it suggests a papilloma or if painful a calculus or cystitis the contracting bladder squeezing blood out of a growth if ulceration has occurred or causing laceration of its walls from a sharp stone.

Blood intimately mixed with the urine may be due to pre renal causes or may come from the kidney, ureter or the bladder. If of vesical origin it suggests continuous bleeding as from a papilloma but as a rule if the act of micturition is observed the terminal portion of the urine will be found to be more heavily blood stained than the initial.

Cystoscopy is essential for the diagnosis of vesical causes of hæmaturia. It is also of extreme value in the investigation of upper urinary bleeding as it will determine from which ureteric orifice the blood is emerging.

The following table summarizes the more important causes of hæmaturia together with its relation to the act of micturition its association with pain and its site of origin.

	Relation to Micturition	Origin	Cause
Painful	Initial	Urethra	Acute urethritis Caruncle Rupture
	Terminal	Bladder	Cystitis (acute or chronic) Ulceration (simple or tuberculous) Calculus Growth (usually malignant) Carcinoma of prostate Foreign bodies
	Mixed	Ureter	Calculus Blood clot Ureteritis Ureteric stricture
		Kidney	Calculus Hydro- or pyonephrosis Tuberculosis Laceration or gunshot wound Pylonephritis Movable kidney Embolism and thrombosis of renal vessels

	Relation to Micturition	Origin	Cause
Painless	Initial	Urethra	Growth (very rare)
		Bladder	Growth (usually innocent) Congested prostate Enlarged prostate Stone (occasionally) Varicose vein Purpura of bladder Schistosomiasis especially in patients returning from overseas
	Mixed	Ureter	Growth } very rare Ureterocele }
		Kidney	Growth (usually malignant) Calculus Hydro or pyonephrosis } some cases Tuberculous Congenital cystic kidney Essential hæmaturia or hæmaturia from minute foci
		Pre renal	Purpura scurvy Arteriosclerosis Mitral stenosis with fibrillation Sub acute bacterial endocarditis Drugs or poisons e.g. turpentine High protein diet Excessive exercise Embolus

## PYURIA

Normal urine is sterile and free from pus cells although on microscopic examination leucocytes may be found in the absence of inflammatory disease

The presence of mucus as shown by cloudiness which disappears neither by heat nor by the addition of acetic acid indicates an inflammatory lesion in some part of the urinary tract which may be primary or be secondary to some underlying cause such as obstruction stone or new growth

Pyuria may be of upper or lower urinary or of genital origin but there is always a tendency for infection to spread to other parts of the urinary and genital tracts. For example urethritis due to gonorrhoea may involve the prostate seminal vesicles and epididymes although this is uncommon with sulphonamide and penicillin therapy. Cystitis may be secondary to a descending infection from the kidney as in renal tuberculosis and inflammation of the bladder may lead to pyelonephritis by ascending spread. It is not generally known that a non specific urethritis may be the first symptom of renal tuberculosis

As a rule both pus and organisms are present together in the urine, although there are two very definite exceptions—(1) sterile pyuria and (2) bacilluria

1 Sterile pyuria—This occurs very commonly in renal tuberculosis when an acid urine will be found to contain pus cells sometimes a few red blood cells but no organisms. If careful urological investigation fails to establish

renal or genital tuberculosis the diagnosis is probably one of non bacterial cystitis—a very definite entity and rather intractable in nature

2 **Bacilluria**—This will be discussed under a separate heading

Inflammatory disease may be present in the urinary tract without the presence of pus as in a closed pyonephrosis. If the obstruction at the uretero pelvic junction is intermittent constitutional symptoms such as fever and renal pain will coincide with clearing of the urine and alternate with periods when these symptoms are absent and the urine is cloudy. Genital infection may also be present when the urine is normal for example in chronic prostatitis and seminal vesiculitis. The amount of pus present in the urine is not always an indication of the gravity of the lesion as typified by early renal tuberculosis. Gross pyuria is usually a symptom of pyonephrosis an infected vesical diverticulum or of abscesses communicating with the bladder from without

The reaction and odour of the urine serve as a rough guide to the nature of the organism present. Thus the Bact. coli and the streptococcus occur in acid urine the former giving rise to a fishy smell. The staphylococcus and B. proteus cause ammoniacal decomposition and thus alkalinity with a smell suggesting a stable

Pus from the urethra settles quickly in a urine glass and has a feathery fluffy appearance. Pus of cystitis is billowy and does not readily sink to the bottom—the urine is usually of high colour and specific gravity. In chronic cases it may resemble *café au lait*. Pus from an infected kidney produces a milky urine and on standing there is a solid yellow or greenish yellow layer on the bottom and an opalescent urine above of low specific gravity and pale colour. A combination of renal and vesical pus results in the solid flat layer already described with a billowy supernatant fluid. Apart from a urethritis in which pus can be expressed from the urethra and in which the first specimen of urine is cloudy and the second clear the only accurate method of localizing the source of the pyuria is to take into consideration other symptoms such as hæmaturia and upper or lower urinary tract pain and to carry out certain special investigations. Thus non specific infections of the urethra and genital organs call for urethroscopy rectal examination and examination of the urine after prostatic and vesicular massage. Inflammation of the bladder when acute symptoms have passed off requires cystoscopy both for confirmation of the diagnosis and a search for a primary cause. Inflammations of the kidney can only be completely investigated with the aid of intravenous pyelography cystoscopy ureteric catheterization and in some cases ascending pyelography

### BACILLURIA

In bacilluria the urine although teeming with bacteria contains very little or no pus. Inflammatory lesions in the urinary tract are either absent or minimal in severity. The sites of infection are most commonly the renal pelvis and the prostatic urethra in association with prostatitis. Constitutional symptoms are absent. The commonest organisms found are the Bact. coli various cocci and the B. typhosus in that order of frequency.

The disease occurs in both sexes and at all ages but is commonest in women and children.

The most important predisposing cause is urinary stasis. Other factors include chronic constipation indigestion diarrhoea and phosphaturia. Typhoid fever may be complicated on the fifteenth day onwards by a typhoid bacilluria

and other fevers such as measles scarlet fever, diphtheria or smallpox, may give rise to a Bact. coli bacilluria

Bacilluria may occur in a previously healthy urinary tract or may supervene on a pre existing disease such as pyelonephritis and urethritis, or may follow per urethral resection of the prostate open operations on the urinary tract and even urethral instrumentation. It is difficult to explain why certain individuals should develop a bacilluria and others the usual inflammations accompanied by pyuria

**Clinical features**—The urine though hazy, contains little or no deposit when centrifuged and microscopy reveals the remarkable disproportion between bacteria and pns cells the latter in some cases, being completely absent

Rotation of the urine in a conical glass produces a picture of a shimmering mist or smoke in a vortex

Renal infections may be unilateral or bilateral and are often intermittent. They may give rise to no symptoms or, at most to a little renal aching. In urethral cases there may be slight frequency of micturition dysuria and perineal aching, if prostatitis is present. There may be a history of preceding urinary disease and there may be some vague ill health and loss of weight. The reaction is usually acid and the urine has frequently a fishy smell

In children bacilluria may lead to frequency of micturition and even incontinence

**Diagnosis**—This is made by considering the symptoms urine analysis, and the same special examinations which are used in cases of pyuria. By this means the presence or absence of underlying urinary or genital disease is determined and the bacilluria localized to its site of origin

**Treatment**—Any underlying cause if present should be removed, whether renal, genital, or extra-urinary (i.e. intestinal). In uncomplicated cases treatment resembles that of the commoner inflammatory diseases of the urinary tract and consists usually of sulphonamide therapy, such as sulphathiazole or sulphadiazine with or without renal lavage

## OXALURIA

The daily excretion in the urine by the healthy adult of oxalic acid in the form of calcium oxalate, averages 15 mg. The term Oxaluria is used when the amount excreted is much in excess of this figure, and when dumb bell or octahedral crystals are found in the deposit of a freshly passed specimen glistening particles may even be seen in clear urine by the naked eye. Oxalates are held in solution in the urine by the acid sodium phosphate and are derived from both exogenous and endogenous sources

**Exogenous**—Although derived from the food, the rate of absorption of oxalates depends on intestinal fermentation. Vegetable foods contain more than animal the main sources being rhubarb, spinach, tomatoes all berries asparagus green tops, celery, and plums. Absorption is reduced by alkalis and is increased by acids (i.e. hyperchlorhydria) and by the fermentation which accompanies a diet rich in carbohydrates such as starch or sugar

**Endogenous**—This is the result of tissue break-down and occurs even when the patient is on an oxalate free diet

Although calcium oxalate stones are only formed in acid urine oxaluria may occur, not only in acid urine in association with uric acid and urates, but also in neutral or alkaline urine in association with amorphous phosphates

**Clinical features**—Oxaluria often occurs in dyspeptic, nervous individuals but may, in itself, cause indigestion mental depression and even neurasthenia

The symptoms may mimic all those of a renal ureteric or vesical calculus but are not aggravated by exercise. They are caused by irritation of the kidneys and urinary tract and may vary from renal aching with some increased frequency from bladder irritation together with the presence of oxalate crystals and some red blood cells in the urine to severe renal colic due to the passage of clumps of calcium oxalate crystals down the ureter together with frank hæmaturia and strangury. The pain or aching may be unilateral or bilateral.

**Diagnosis**—This is made when symptoms are present suggesting the presence of a renal ureteric or vesical calculus but a stone is excluded by cystoscopy and pyelography and an uninfected urine free from phosphates is found to contain excess of calcium oxalate crystals and some red blood cells.

**Treatment**—This consists of four D's

1 **DIGESTION**—Digestive faults must be corrected the bowels regulated and intestinal fermentation prevented as far as possible.

2 **DIET**—Food rich in oxalates especially the vegetable foods mentioned above should be avoided and also a diet rich in starch or sugar. A pint of milk should be given daily whereby a marked proportion of oxalate is converted into calcium oxalate and excreted unchanged in the faeces.

3 **DRUGS ETC**—Alkalis such as bicarbonate of soda or alkaline water such as Vittel Contrexeville or Vichy diminish the absorption of oxalates. If chronic constipation is present magnesium salts can be substituted for bicarbonate of soda. If marked vesical irritation is present an alkaline mixture such as the following is useful.

Soda Bicarb	}	aa gr XX
Soda Cit		
Tinct Hyoscyam		℥ XX
Tinct Belladonnæ		℥ V
Spts Chlorof		℥ λ
Aqua Meth Pip		ad 3ss

4 **DIURESIS**—The fluid intake should be increased but hard water avoided.

## PHOSPHATURIA

The daily excretion in the urine of phosphoric acid in the form of phosphates averages 2.5 gm.

Phosphates are described as alkaline and earthy the proportions being two to one and in addition there is the acid sodium phosphate upon which the acidity of normal urine depends.

**Alkaline phosphates**—These consist of the phosphates of potassium and sodium which remain in solution whether the urine is acid neutral or alkaline.

**Earthy phosphates**—These comprise phosphates of calcium and magnesium and are soluble only in acid urine and precipitate when it is faintly acid neutral or alkaline.

Phosphates are derived mainly from the food and slightly from the tissues.

In cases where the urine is alkaline from ammoniacal decomposition there is a deposit of ammonium magnesium phosphate.

The term phosphaturia is used when the urine on voiding is cloudy, but clears on the addition of acetic acid thereby excluding the presence of pus.

Two forms of phosphaturia are recognized (1) Phosphaturia due to an increase of both alkaline and earthy phosphates without alteration of the

normal proportion of two to one (2) An increase of phosphates mainly of the earthy variety which may equal or even exceed the amount of alkaline phosphates present The latter variety is the more serious and has been called phosphatic diabetes

Phosphaturia usually of the first variety may be caused by worry loss of sleep excessive smoking fatigue or a heavy meal and is thus physiological in origin and as a rule requires no special treatment other than acidification of the urine It gives rise to some degree of frequency of micturition and scalding during the act

In true phosphaturia (or phosphatic diabetes) the symptoms are much more severe and like oxaluria may mimic urinary lithiasis Gastric or duodenal ulcer is a contributory factor In some cases phosphaturia alternating with bacilluria may be a symptom of vesiculo prostatitis In addition to frequency of micturition and scalding which can be very marked there may be renal aching or even colic together with pain in the suprapubic area In some instances there is a urethral discharge In chronic cases cystoscopy may reveal an incrusting phosphatic cystitis quite distinct from the deposit of ammonium magnesium phosphate from ammoniacal decomposition of the urine which occurs in connection with foreign bodies malignant growths or ulcers and old standing cystitis Sexual symptoms are common usually taking the form of impotence and premature ejaculations

**Treatment**—In the physiological variety no treatment is as a rule necessary In true phosphaturia (or phosphatic diabetes) however treatment must be considered under five headings

1 The patient must be reassured in his own mind that he is not suffering from urinary or genital disease and it is often a wise step to add a little acetic acid to the urine in his presence The clearing of the urine may act like a charm He should be relieved of all worry and anxiety and in the case of an air pilot removed at all events temporarily from operational tours Regular meals and exercise together with plenty of sleep and rest are essential A gastric or duodenal ulcer must receive appropriate attention

2 **Drugs**—Tonics such as iron and strychnine and acids such as hydrochloric nitro hydrochloric and acid sodium phosphate are indicated and may be combined in the following prescription

Tinct Fern Perchlor	m ℥
Acid Sodium Phosphate	gr X
Acid Phos dil	m VIII
Acid Nit Hyd dil	m V III
Liquor Strychninae	m III
Spts Chlorof	m X
Aqua	ad ʒss

As an alternative to acid sodium phosphate ammonium chloride tablets grs 15 may be given three times a day

3 **DIET**—An acid type of diet rich in vitamins is indicated Milk and other calcium foods should be avoided as also alcohol tea coffee and tobacco

4 **DIURESIS**—The fluid intake should be increased to 5 pints in the twenty four hours

5 **INCrustING PHOSPHATIC CYSTITIS**—This is a rare condition but responds readily to bladder washouts with Solution G (Suby and Albright 1943)

Citric acid (monohydrous) 32.3 gm Magnesium oxide (anhydrous) 3.8 gm  
Sodium carbonate (anhydrous) 4.4 gm Distilled water to 1000 ml

Deposits of ammonium magnesium phosphate on pre existing pathological conditions in the bladder such as foreign bodies ulcers and malignant growths do not constitute a phosphaturia and cure depends on removal of the cause

### CHYLURIA

The term chyluria is used when the urine contains fat as a result of a communication between the lymphatic system and some part of the urinary tract, usually the renal pelvis or calyces. It may occur in filariasis (Fig. 21) in which there is lymphatic obstruction



FIG. 21

Cystoscopic appearance showing varicose and tortuous lymphatics in a case of chyluria (Raj and Sundar)

Very rarely it may occur from other obstructive causes such as stricture of the thoracic duct or pressure on it by neoplasms, cysts aneurysms or abscesses. Whatever the cause there is rupture of the dilated lymph vessels of the renal pelvis—less frequently the ureter or bladder—into the lumen of the urinary tract.

The urine is milky and on standing a creamy layer separates and rises to the surface. The addition of ether and shaking, clears the urine by extracting the fat.

**Diagnosis**—The condition is diagnosed by microscopical and chemical examination of the urine the history of exposure and the presence of other signs of filariasis such as elephantiasis and demonstration of the embryos in the blood or urine.

**Treatment**—This is mainly symptomatic. The diet should contain little fat. In very rare cases nephrectomy may be indicated if the chyluria is unilateral and the patient is losing weight or suffering from severe renal colic. A ruptured vesical lymphatic has successfully been treated by cystoscopic diathermy.



### PNEUMATURIA

Pneumaturia consists of the passage of gas in the urine, usually at the end of micturition and is accompanied by a characteristic tickling sensation and a frothy bubbling sound

**Causation**—1 Accidental introduction of air during instrumentation, such as cystoscopy This is of common occurrence and of no clinical significance but its possibility should always be explained to the patient after such examination

2 The liberation of hydrogen during the coagulation diathermy of vesical papillomata Here again, the patient should be warned

3 Vesico intestinal fistula as a result of diverticulitis, carcinoma of the colon, or, very rarely, from appendicitis

4 Spontaneous formation of carbon dioxide usually due to the action of *Bact coli* and occasionally *B proteus* on the sugar present in the urine of a diabetic patient, with resulting fermentation

**Treatment**—Accidental introduction of air and liberation of hydrogen during coagulation diathermy require no special comment other than the advisability of warning the patient Vesico intestinal fistula is diagnosed by cystoscopy and must be dealt with by colostomy and, if possible, removal of the intestinal cause Diabetic cases require appropriate treatment

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## CHAPTER VI

### MOVABLE KIDNEY (NEPHROPTOSIS)

THE range of mobility of the kidney in the normal individual varies from 2 to 5 cm. If the abdominal walls are fairly strong and the adipose tissue is normal in quantity the kidneys cannot be palpated unless they are enlarged or displaced. When, however, the amount of fat is less than usual and the abdominal walls are weak or have been relaxed by child bearing the lower pole of each kidney, especially that of the right, can often be felt during inspiration.

Three degrees of abnormal mobility may be described in accordance with the results of abdominal examination. In the first one half or more of the kidney can be grasped between the hands during inspiration but recedes on expiration, in the second the organ has its normal peritoneal relations but can be grasped between the hands and retained during expiration, in the third it has a loose pedicle and tends to float towards the anterior abdominal wall. A kidney which moves freely behind the peritoneum as described in the first two degrees of abnormal mobility, is said to be *movable*. When it is more or less surrounded by peritoneum and can be moved freely about the abdomen in all directions it is known as a *floating kidney*.

#### ANATOMY OF ABNORMALLY MOBILE KIDNEY

It should not be assumed that abnormal mobility of the kidney is always accompanied by pathological lesions within the organ. Intravenous pyelography may demonstrate the functional activity and the outline of the pelvis and calyces of such a kidney to be normal in every way. Also it should not be forgotten that in many cases a movable kidney only forms part of a general visceroptosis.

As the anterior and posterior lamellæ of the perirenal fascia do not coalesce below, an abnormally mobile kidney may move downwards and inwards and thereby cause an elongation of the perirenal space. The perirenal fascia encloses and in a special way supports the suprarenal body which very rarely, if ever, accompanies the kidney in its abnormal movements. In contrast with the perirenal fascia which may be thickened the perirenal fat is as a rule noticeably atrophic. When the kidney has been inflamed part of the fatty layer may adhere to the organ and move with it.

As the kidney descends it swings as a whole on its pedicle towards the middle line while at the same time it often rotates either round a transverse or vertical axis. Kinking or torsion of the renal vessels and ureter may result from these movements. Excessive mobility of the kidney may cause the pedicle to undergo elongation which in itself tends to make torsion more likely.

As a result of the torsion there may be interference with the blood supply, leading to enlargement of the kidney, albuminuria, hæmaturia or suppression of urine.

When the kidney is abnormally mobile the ureter, which is comparatively speaking fixed, is likely to become kinked, with resultant obstruction to the outflow of urine, a hydronephrosis may result from this state of affairs.

the surgeon's eye. Sometimes the lateral position is advisable. Palpation of the abdomen with the patient erect but bending slightly forwards may reveal abnormal renal mobility which would otherwise escape detection.

The examination should be conducted in accordance with the requirements of each individual case.

The symptoms which accompany abnormal mobility of the kidney may be referred to the urinary tract, gastro-intestinal tract or nervous system.

**Symptoms referred to the urinary tract**—Pain which is the most constant symptom is as a rule a dragging ache felt in the posterior renal angle or in the region in front of the kidney pedicle. The ache is increased by movement and often by menstruation may radiate along the ureter or be referred to other regions such as the groin. It is usually relieved if the patient lies on her back but is apt to recur if she lies on the side opposite to the abnormally mobile kidney.

In rare cases the patient complains of acute attacks of violent pain like that of renal colic. These attacks (DIETL'S CRISES) may be due to kinking of the ureter to twisting of the kidney pedicle or to the kidney dragging on the duodenum. They are usually precipitated by violent exertion and relieved by rest in bed the foot of which should be raised. If the ureter is kinked a unilateral swelling tender on palpation can as a rule be felt in the renal area and the outflow of urine is diminished or even ceases. The attack rarely lasts more than a few hours and is followed by polyuria and pollakiuria. Twisting of the renal pedicle gives rise to similar features and may cause albuminuria or hæmaturia.

**ABNORMAL MOBILITY**—As already described on p. 61 three degrees of mobility are recognized. In the lesser degrees of nephroptosis the kidney moves in a line parallel with the vertebral column. In the more extensive degrees of mobility the lower pole of the organ swings inwards and the hilum instead of normally facing towards the middle line may face upwards while in extreme cases where the pedicle is so long that it has little or no control on the movements of the kidney the organ may be found in almost any part of the abdomen. It has been known to descend into the pelvis where it was felt from the rectum. If the kidney is out of place at the time of examination a tumour with a smooth rounded surface and reniform in shape is felt in the abdomen. A sickening pain is experienced on handling the organ which can be squeezed back into the renal fossa with a characteristic jerk.

Kinking of the ureter as a result of abnormal renal mobility is a common cause of hydronephrosis. If the obstruction is temporary the pelvis empties itself when the outflow becomes free again but as the kinking and therefore the obstruction usually recur repeatedly changes gradually take place in the anatomical relations of the parts which tend to cause a permanent retention of the urine and to convert an open condition from which fluid can escape into a closed hydronephrosis from which it cannot.

The excessively frequent micturition sometimes experienced in connection with a movable kidney may be due to a reflex action of the bladder or to a renal crisis followed by polyuria and therefore by increased desire to pass water.

Slight hæmaturia sometimes occurs in cases of movable kidney owing to intermittent kinking or torsion of the blood vessels. Albuminuria and tube casts may also be present and usually disappear on resting or after the operation of nephropexy.

**Symptoms referred to the gastro-intestinal tract**—In cases attended with symptoms of gastro-intestinal disturbance the pain is usually in the epigastric region is often accompanied by nausea and vomiting and may be followed by atonic dyspepsia.

Jaundice pyloric obstruction and dilatation of the stomach are said to result in some cases from the movable kidney dragging on the duodenum. In other cases the abnormal mobility of the organ is blamed for causing colicky pains and constipation by dragging on the colon. It is, however, very difficult to estimate how far the nephroptosis is responsible for these symptoms.

**Symptoms referred to the nervous system**—The patient may complain of neurasthenic manifestations such as depression and irritability, but in some cases these nervous symptoms are out of all proportion to the local findings.

### DIAGNOSIS

The diagnosis of movable kidney is based upon the history, age, type of patient, palpation and pyelography. The condition is as a rule found in women who are of thin build, occurs

much more frequently on the right than on the left and usually makes its appearance between the ages of 25 and 40. The patient as a rule gives a history of pain which is usually a persistent dull or dragging ache felt in the renal region, and increased by movement.

*On palpation* a tumour, reniform in shape, is felt in the loin or found to be freely movable in the abdomen, and can be returned to the renal fossa without difficulty. The patient experiences a sickening pain when the organ is handled.

*Pyelography*, which is the most reliable method of examination for demonstrating the extent of the mobility, is necessary to ascertain the amount of dilatation, if any, of the renal pelvis and calyces (Fig 22). Of the two types of pyelography, intravenous is more valuable than retrograde. The advantages of the former as compared with the latter method are that it is more simple to use, probably gives a more true picture of the position of the kidney and is not so likely to lead to complications. If retrograde pyelography is used the catheter should be withdrawn into



FIG 22

Retrograde pyelogram showing ptosis and a little rotation of right kidney with slight dilatation of renal pelvis.

the pelvic ureter before the pyelogram is made, so as to avoid interference with the movements of the kidney or with the demonstration of ureteric kinks. Pyelograms should be made during expiration with the head of the table slightly lowered and during inspiration with the head of the table raised.

Before the introduction of pyelography, growths of the colon, enlargements of the gall bladder, ovarian cysts with long pedicles, accessory lobes of the liver, mesenteric cysts, splenic cysts, retroperitoneal cysts and uterine fibroids were some of the conditions which were confused with movable kidney.

Radiography after an opaque meal may be advisable so as to ascertain if the movable kidney is part of a general visceroptosis.

## TREATMENT

Before recommending treatment in any case of movable kidney the surgeon should make thorough investigation of the patient in order to ascertain as far as possible that the symptoms complained of are due to the abnormal mobility. In cases where neurasthenic and gastro intestinal symptoms are present it is sometimes difficult, if not impossible, to determine how far the nephroptosis is responsible.

The patient may not complain of any symptoms connected with the undue mobility of the kidney, but the condition is discovered during the course of a routine investigation. If in such a case there are no changes in the organ it is usually unwise to mention the abnormality to the patient, as in the majority of such cases no treatment is necessary.

The treatment of cases of movable kidney attended by symptoms which definitely appear to be renal in origin is still a very much debated question. Some surgeons rely on palliative measures and never operate except in cases where practically all the excretory tissue has been destroyed, where of course they do a nephrectomy. Others are such enthusiastic advocates of nephropexy that they do a fixation of the organ in practically every case. In the absence of a general visceroptosis or some other contraindication nephropexy is in my opinion, advisable where the kidney has undergone changes but is not disorganized, or where there are renal symptoms not amenable to palliative measures, if such changes or symptoms can undoubtedly be attributed to the abnormal mobility.

**PALLIATIVE TREATMENT INDICATED**—(1) In mild cases where pyelography fails to demonstrate any dilatation of the renal pelvis or calyces. In such cases palliative measures should be tried before resorting to operation. (2) Where severe neurasthenia is present and no changes can be detected in the kidney. But if any evidence can be produced to show that the neurasthenic symptoms are due to the abnormal renal mobility, operation might be recommended. (3) Where general visceroptosis is present.

**OPERATIVE TREATMENT**—1 *Nephropexy indicated*—(1) Where the abnormal mobility is causing changes in the kidney as demonstrated by pyelography and examination of the urine. (2) Where symptoms are severe, such as the occurrence of repeated Dietl's crisis. (3) Where the condition of the kidney is having harmful effects upon other organs.

2 *Nephrectomy* is recommended where the kidney is disorganized by hydronephrosis or other disease provided the other has been proved to be present and is of adequate functional efficiency.

**Palliative treatment**—Treatment by ordering rest, fattening foods, massage and possibly mechanical support. Rest and good food are specially indicated in patients who are thin and inclined to be neurasthenic. In these cases much relief can often be obtained by, say, six weeks in bed combined with good food, massage of the abdominal region and special exercises for the development of the abdominal muscles. With a view to strengthening the abdominal wall I advise patients while lying flat upon their backs to raise the legs to the vertical position, keeping the legs at full stretch and the knees stiff, also while their feet are held down to raise their body into a sitting position. The number of movements prescribed will depend upon the physical fitness of the patient.

Any accompanying disturbance of the stomach, bowels or urinary tract is treated by ordering appropriate remedies.

In other cases especially those where a general visceroptosis is present the application of a carefully fitted abdominal support such as the Curtis belt may be sufficient to keep the patient comfortable it should be applied when the patient is lying down and preferably with the pelvis raised

Various types of kidney truss or corset have been used but as a rule unless there is a general visceroptosis I do not advocate the use of mechanical support Personally I have not much confidence in the efficiency of a truss or corset to support a movable kidney Yet some patients state that a particular apparatus keeps them free from symptoms and in such cases where the effect is probably more psychical than mechanical I do not discourage its use A belt or corset with an air cushion or pad fastened within may have a harmful instead of a beneficial effect if improperly fitted or if the kidney is very movable In such a case the kidney slips down below the support and may be prevented from returning to its normal position by the air cushion or pad Also before recommending a belt it should be realized that its long continued use produces a sense of dependence upon it and at the same time a tendency to muscular weakness

If the patient is not resting and develops symptoms suggestive of a Diet's crisis she is at once put to bed the foot of which should be raised This coupled with gentle manipulation usually results in reduction of the kidney into the loin and immediate relief from pain

**Operative treatment**—The operations which may be performed are (1) Nephropexy (2) Nephrectomy which is a last resort and is only indicated when practically all the excretory tissue of the organ has been destroyed and only in cases when a second kidney has been proved to be present and capable of taking on the work of both

For a nephropexy the organ is approached through an oblique lumbar a vertical posterior or an anterior incision

**REMOVAL OF THE PERIRENAL FAT**—Before any attempt is made to fix the kidney all loose connective tissue fascia or fat likely to interfere with the process should be completely removed so that the organ can be brought into direct contact with the muscular layer of the abdominal wall In the operations which are most commonly done part of the true capsule is stripped off the kidney This is carried out by making a small incision through the capsule introducing a grooved director through the incision so that it lies between the capsule and the kidney slitting the capsule along the director and then stripping as much of it as may be necessary from the kidney by blunt dissection

**FIXATION OF THE KIDNEY**—Some of the methods that have been used —

- 1 By sutures passing through the kidney capsule and then through the muscles of the abdominal wall
- 2 By sutures passing through the kidney capsule and kidney substance and then through the muscles of the abdominal wall
- 3 By packing the renal fossa below the lower pole of the kidney with gauze with a view to promoting adhesions
- 4 Supporting the kidney from below by suturing the peritoneum to the posterior abdominal wall
- 5 By partial decapsulation of the kidney and by stitching the stripped capsule to the abdominal wall
- 6 By removing the capsule from the posterior surface of the kidney and passing sutures through the outer or convex border which has not been decapsulated

If the anterior incision has been used the Stanmore Bishop procedure is perhaps the best known. After opening the peritoneal cavity and replacing the kidney in the renal fossa the peritoneum covering the lowest third of the kidney is divided transversely. The renal capsule is then stripped downwards and inwards from the anterior surface of the lowest third of the organ. The posterior opening in the peritoneum is closed and sutures are passed backwards through the peritoneum detached capsule and posterior abdominal wall, so as to form a supporting ledge for the kidney. An incision is made through the skin and subcutaneous fat behind and the sutures tied over the muscular layer.

If the vertical posterior incision is used a modification of Edebohl's method of fixation probably gives the best result. A longitudinal incision is made through the renal capsule just posterior to the lateral convex border. Half

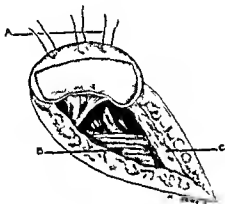


FIG. 23

**Nephropexy.** The greater part of the posterior surface of the kidney has been decapsulated. Three catgut sutures (A) are passed through the convex border of the organ. B quadratus lumborum muscle. C last rib.

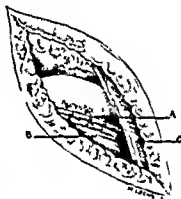


FIG. 24

**Nephropexy.** The three sutures are passed through the quadratus lumborum muscle. A catgut suture. B quadratus lumborum muscle. C last rib.

an inch or more of the capsule is left undivided at the lower pole to act as a sling for the organ, and the parts on either side of the incision are rolled back to form two wings. The kidney is suspended as high as may be thought advisable by suturing each of the two wings to the muscles of the abdominal wall on the corresponding side of the incision with chromic catgut. The suspensory sutures are temporarily secured with artery forceps and are not finally tied until the muscular wound has been closed. The result is that the organ is slung up and the stripped renal surface brought into apposition with the bare muscular area on the posterior abdominal wall.

**AUTHOR'S TECHNIQUE.**—The author uses the oblique lumbar incision. The kidney is freed and delivered into the wound. The renal pelvis is examined and the ureter is freed as far down as possible in order to make sure that there are no adhesions obstructing the urinary outflow. All loose connective tissue, fascia or fat likely to interfere with the fixation is removed so that the organ can be brought into direct contact with the muscular layer of the

abdominal wall. The true capsule is stripped off the greater part of the posterior surface of the kidney. Three catgut sutures are passed first through the convex or outer kidney border, which has not been decapsulated, and then through the outer part of the quadratus lumborum muscle. It is not always possible to fix the kidney exactly in its normal position, and each case must be treated on its merits. The sutures are temporarily secured with artery forceps and tied when all have been inserted after the pelvis and ureter have been carefully examined to make certain that there is no kinking (Figs 23 and 24). If there is persistent oozing it is advisable to insert a drainage tube down to the anterior surface of the lower pole. This should be removed in twenty-four hours.

The patient should not be allowed to assume an upright position for at least four weeks after a nephropexy.

### RESULTS OF NEPHROPEXY

If the examination of the patients is thorough and the cases are carefully selected for the different methods of treatment, a certain percentage of patients will be found in which nephropexy gives most satisfactory results. If the operation is skilfully performed the mortality is very low, probably less than 1 per cent.

Complications such as injury to the peritoneum, or to the pleura, or to the blood supply of the kidney may occur during the operation, and are due to lack of skill or carelessness on the part of the surgeon. Failures are due to incomplete removal of loose connective tissue, fascia, and fat, to not stripping off sufficient of the true capsule, to trying to fix the kidney too high, and to tying the sutures too tightly, causing them to tear out.

The passage of the sutures above the twelfth rib is likely to result in their tearing out, or may cause pneumothorax, and should, in my opinion, be discouraged.

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pressure the colon displaced forwards and the liver or spleen pushed upwards. Rupture which may be due to traumatism may result in the escape of blood into the renal pelvis peritoneal cavity or perirenal space.

**Clinical features**—A small aneurysm as a rule, does not cause symptoms. If the aneurysm is large it gives rise to a palpable swelling in which pulsation can on rare occasions be detected. The interval between the injury and the appearance of the tumour may vary from a few days to as many years. The course is usually if not always, progressive. The tumour is smooth and elastic, is usually not tender, and as a rule it is fixed or only slightly movable.

Hæmaturia is usually an early feature may occur before any swelling is discovered and is probably caused by disordered renal circulation and by congestion. The bleeding due to the aneurysm may be continuous with that due to the injury or may succeed it after a longer or shorter interval.

Pain, which is often present, is usually described as a dull ache, but in rare cases it may be colic like in nature. The pain may be accompanied by nausea and vomiting.

In rare cases a throbbing sensation has been experienced by the patient, while in exceptional instances a loud systolic bruit has been heard over the tumour. Rupture of an aneurysm may be followed by a severe pain or by a fatal hæmorrhage into the perirenal space or peritoneal cavity.

**Diagnosis**—The history and the comparatively rapid development of the swelling are important points in the diagnosis which is however, usually not made until an exploratory operation or a post mortem examination takes place. Pulsation or a systolic bruit can rarely be detected but when present are pathognomonic of the condition.

In cases running a rapid course, diagnosis from ruptured kidney with hæmaturia may be impossible. In a more slowly progressive type of case the condition is likely to be confused with a renal neoplasm. Radiography may give a round or fusiform shadow with a calcified or dense ring-like periphery and a lighter centre. In rare cases the aneurysm may be sufficiently calcified to give a shadow similar to that of a renal stone.

**Treatment**—The treatment is nephrectomy with excision of the aneurysmal sac, provided the other kidney has been proved to be capable of carrying on the work of both. The ruptured and the false aneurysm necessitate immediate operation.

When doing nephrectomy in such cases it is advisable to clamp the pedicle as soon as possible, as the aneurysmal sac is often friable and thin. If severe hæmorrhage occurs during the operation the wound should be plugged with gauze and the renal pedicle exposed and ligatured. The aneurysmal sac and kidney are then removed.

If it is thought that the other kidney is not of adequate functional efficiency, removal of the aneurysmal sac and suture of the artery may be considered, but it is a very dangerous procedure.

In the course of an exploratory operation care must be taken to avoid mistaking the pulsation of a prominent aorta for an aneurysm of the renal artery.

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large preponderance of motor traffic anyone run over and injuring a kidney is almost certain to be killed by injury to the chest or abdomen. The weight of the modern car or bus makes the chance of survival negligible.

An analysis of the 53 cases admitted to the London Hospital may be of interest

Causes—Falls and crashes	23
Football injuries	11
Blows	6
Cycle accidents	7
Motor car accidents	4
Kicks by horses	2
Total	<hr/> 53 <hr/>

Apart from these cases it is not uncommon to see one or two students in the football season with slight hæmaturia due to blows in the loin whose symptoms clear up with rest at home and who are not admitted to hospital.

In the series enumerated above the right kidney was injured in 21 cases and the left in 32. This preponderance of the left side over the right was particularly noticeable in the case of falls—14 left to 9 right—and in the football injuries in which the proportion was of left to right 8 to 3. This may be due to the fact that most players are right footed and therefore their right leg being behind or in front in the process of kicking protects that side. Forty of these patients (75.5 per cent.) did not require any surgical interference and recovered with rest in bed.

**Pathological anatomy—THE KIDNEY**—Different degrees of injury may be recognized as follows. Contusions cortical fissures complete tears disintegration of renal substance.

**Contusion**—The lesion goes no further than an extravasation of blood beneath the renal capsule and through the renal substance. This kind of lesion may be produced by the manipulations required when there is difficulty in delivering the kidney on to the loin.

**Cortical tears**—Both the renal capsule and parenchyma are the seat of a number of fissures of varying extent which do not involve the pelvis. They are more commonly towards the posterior surface.

**Complete tears**—The whole thickness of the organ is involved and the fissure extends into the pelvis. The kidney may be divided in this way into several fragments.

**Disintegration of the renal substance**—The kidney is either pulped or separated into numerous fragments.

**Experimentally**—It has been shown that in the tubules in the vicinity of the tear there is degeneration of epithelium as an early phase but the glomeruli are more resistant. Cicatrization occurs later and where the injury has been extensive atrophy and cyst formation are likely to result. There is no reconstruction of severed tubules but neighbouring areas of renal tissue clearly show compensatory hypertrophy. This takes the form of an increase in size of glomeruli, tubules and the epithelium which line these structures.

**THE PERIRENAL TISSUES**—Even in the absence of any demonstrable kidney lesion the perirenal fat may be the seat of extravasated blood which in due course may give rise to infection. When the kidney is torn the amount of blood diffused into the area may be abundant and produce a hæmatoma of considerable size.

Urine as well as blood may collect in this locality and give rise to a swelling of large dimensions. Such a swelling is termed a pseudo hydronephrosis (see late complications).

**THE RENAL PEDICLE**—Accompanying the renal lesions there may be injury of varying degree to the structures of the renal pedicle. If the pelvis or the ureter is torn then there will be extravasation of urine and a pseudo hydronephrosis will result.

When the blood vessels are involved hæmorrhage may be so severe as to be rapidly fatal.

Sometimes injury to the renal pedicle occurs independently of injury to the kidney itself.

**Symptoms and signs**—These vary but there is one symptom that is found in every case and that is hæmaturia. The extent of this symptom varies from only a red tinge in the urine to quite severe staining. Clot colic has been present in a few cases. In this series of cases the shortest duration of hæmaturia was one day and the longest a fortnight. The average period for the forty cases was 4.8 days. In severe cases it did not appear till the day after the accident the patient continuing his work or his game following the injury.

A constant sign was tenderness at the site of injury. In four cases a lump was said to be palpable in the loin but it disappeared in every case before leaving hospital. I always think it is difficult to be sure of a renal swelling unless it is large or mobile in the presence of loin tenderness as one is apt to mistake the rigidity of the muscles for a swelling.

Three cases were complicated by fractured ribs and one by a fracture of the first, second and third lumbar transverse processes.

In cases in which the hæmaturia persists for a week or more or in which it recurs when the patient gets out of bed pyelography should be performed to exclude the possibility of previous renal disease. If an intravenous pyelogram fails to show the kidney as occurs in some cases a retrograde pyelogram should be done.

Robertson recommends that a pyelogram should be done at intervals for three or four years after the accident in case the formation of fibrous tissue should obstruct the pelvis.

In one case in this series this examination showed a congenital cystic kidney. I have had two cases—one in this series and one privately—where the retrograde pyelogram showed a hitherto unsuspected hydronephrosis both due to an obstructing renal artery.

One was a schoolboy who was kicked in the left loin whilst playing rugby football. He had profuse hæmaturia and on examination a lump was found in his loin. The lump persisted after the hæmaturia had ceased so he was admitted to hospital. On going into his past history I found that he had had periodic attacks of pain—never severe—in the left iliac fossa which had been attributed to constipation. A retrograde pyelogram showed a large hydronephrosis for which I performed a nephrectomy.

The other case was that of a big game hunter who was elephant hunting in East Africa. Meeting an elephant in a narrow glade he shot it but only wounded it and before he could reload the elephant charged. In attempting to step behind a tree he caught his foot in the undergrowth and fell; the elephant came on and straddled him and then hit him in the abdomen with the butt of its trunk. His bearer then had an equally unsuccessful shot at the elephant who made off. The bearers carried the hunter on an improvised stretcher to a mission station thirty-six hours away. By the light of the moon the patient noticed he had hæmaturia. Later he came to England.

and I saw him. He had had further attacks of hæmaturia and I felt a large lump in his right loin which a pyelogram showed was a hydronephrosis, so I did a nephrectomy. He had had no previous symptoms, but nothing short of severe pain would have worried him.

Of the remaining 13 cases 11 were operated on and 2 died with surgical intervention. Of the latter, one had a fractured skull and died of meningitis, the second ruptured his right kidney owing to fracture of his lumbar transverse processes, but he also had a fractured pelvis and a fractured femur and died of shock soon after admission.

In the 36 cases of accidental death in which the kidney was involved Gutterbock reported as complications fracture of ribs in 21 cases, laceration of liver in 20, rupture of spleen in 13 and rupture of intestines in 3.

Of the 11 operated on 2 died (18 per cent). One had fractured ribs and a hæmoperitoneum, and at operation his left kidney was found to be in three pieces, the tears radiating from the hilum to the cortex. The other man was crushed between two lorries and was admitted severely shocked and suffering from internal hæmorrhage. Laparotomy revealed a ruptured spleen and ruptured left kidney, both were removed but the patient died of pneumonia five days later.

Of the 9 cases that survived, 3 were caused by falls from a height, 3 by football injuries, 2 by cycle accidents and 1 was run over by a cart. One of the football injuries was that recorded previously, where there was a large hydronephrosis. One case was complicated by fractured ribs.

On admission all the cases showed a marked degree of shock, with pallor, rapid pulse and in some vomiting. Every case had profuse hæmaturia and there was pain, tenderness and rigidity in the side affected. In 3 cases a lump could be felt in the loin. In some cases there were also signs of peritonism shown by vomiting and abdominal rigidity.

**LATE COMPLICATIONS—Perinephritis**—Though the patient may appear to recover from the initial injury and the hæmaturia may cease it is always necessary to be on the look out for late complications, the most important of which is sepsis. It is well known that although urine when secreted may be sterile, if it gets into the tissues it will inevitably produce infection. The same applies to the infection "resisting" peritoneal cavity as is seen in intraperitoneal rupture of the bladder. Where there is a large collection of blood clot round the injured kidney, as is seen in those with a palpable lump and hæmatoma in the loin, this is very liable to happen.

The first symptom would be increasing pain and tenderness in the loin. There may also be pain in the iliac fossa on the same side and in some cases psoas spasm shown by the patient keeping his thigh flexed and unable to straighten it without pain. The temperature will rise and present the typical swinging chart of a septic infection.

On examination the lump in the loin will be more tense and probably increasing in size. The general condition of the patient will show signs of deteriorating. There may be pus in the urine.

Later the infection may spread to the overlying skin, which will get red and oedematous and show signs of fluctuation.

Once the signs of a perinephric abscess have appeared, then it should be incised and the abscess drained. A careful watch must be kept all the time for any secondary hæmorrhage from the ruptured infected kidney. If this occurs then nephrectomy is necessary.

Once the perinephric abscess has healed, the temperature subsided and the lump disappeared, then the kidney should be investigated, preferably

by an intravenous pyelogram to see if it is functioning satisfactorily and the extent of the damage incurred. If the intravenous pyelogram is unsatisfactory then a retrograde may be done but there is always a certain risk of nephritic inflammation.

If these investigations show that the kidney is of little value or that it is keeping up a chronic infection as shown by the continued discharge of pus then a nephrectomy should be performed if the remaining kidney is normal.

In every case in which there has been evidence of perinephritis and the kidney has been left, periodic pyelograms should be done in case scarring may cause obstruction to the ureter or pelvis and so produce a hydronephrosis.

*Pseudo Hydronephrosis*—This is a term given to a collection of urine round a kidney and generally results from a fissure which involves the pelvis, a group of calyces or a main calyx. It is an uncommon complication. The wall consists of dense fibrous tissue without any epithelial lining. The contents consist of blood and urine mixed. In old standing cases the communication between the interior of the kidney and sac may close completely.

The tumour caused by the extravasation may occur quickly or only after the lapse of a considerable interval. Fluctuation is a prominent feature when the swelling is large. In certain cases urography will be able to throw light on the



FIG. 26

Intravenous urogram in a man aged 67 years, ten months after injury to right kidney. The kidneys are seen to be in their normal positions. The irregular shadow towards the outside of the right lobe is probably the result of the deposit of urinary salts outside of the kidney. (Mr Winsbury White's case.)

true nature of the condition. Signs of infection tend to develop in due course.

Incision and drainage will be required in the first instance. In due course nephrectomy may be necessary if a urinary fistula persists or to remove a functionless and perhaps infected kidney.

Winsbury White (1934) has reported an interesting case of a man aged 67. Eight pints of blood-stained fluid were evacuated from the right perinephric region twelve months after fracture of some ribs on the right side. The collection of fluid ultimately pushed the right kidney across the mid line.



but there was no sign of injury to intraperitoneal structures. Three had abdominal nephrectomies performed whilst in two there was found an extensive retroperitoneal hæmatoma in one case extending down to the pelvis these were drained and the kidney not removed. In two cases the laparotomy wound was closed and the kidney removed by a fresh incision in the loin. I consider this inadvisable as from our experience in the last war we know that doing a laparotomy and then turning the patient over to deal with wounds in the back produced very profound shock. Three of the cases required blood transfusions. The facility of blood transfusions at short notice in hospital nowadays is a great help in saving the lives of these serious cases.

In these nephrectomies the kidney was found torn in two or three pieces the tears radiating from the hilum to the cortex and in one the ureter was torn. In no case was it possible to save the kidney. Where just one pole is torn off and the rest uninjured it may be possible to remove the injured pole and suture the cut surface.

The mortality rate in a large series of cases collected by various authors is instructive. Keller collected 478 cases in which no operation was performed 107 (22 per cent) died 60 from hæmorrhage and 38 from infection. Suter collected 427 cases without operation of which 88 (20.6 per cent) died 143 were operated on with preservation of the kidney and of these 21 (14.6 per cent) died 131 had nephrectomies and 22 (16.7 per cent) died.

### WAR WOUNDS

**Ætiology and pathology**—These wounds were caused by bullets shrapnel or jagged pieces of high explosive shells or bombs (Fig 28). The number that reached the casualty clearing station was extremely small and of these a good many were moribund on arrival. The reason is easy to understand when you think of the anatomical position of the kidneys. A shell fragment penetrating the kidney is also very likely to tear a hole in the liver spleen or the large abdominal vessels with the result that the soldier dies rapidly from hæmorrhage before anything can be done for him. If he survives to be picked up he has to face the long journey by stretcher and ambulance back to the nearest operating hospital with the cold and wet of winter to add to his misery so it is not surprising if he arrives moribund.

I was surgical specialist of a casualty clearing station for the last two and a half years of the 1914-18 war eighteen months of which was spent at an advanced operating centre at the base of the Loos salient into which all the abdominal cases were admitted. The number of renal cases amongst the larger number of abdominal operations I performed was exceedingly small.

Sir Cuthbert Wallace in 1917 analysed 1200 cases of gunshot wounds of the abdomen 965 were operated on and only in 73 cases (7.5 per cent) was the kidney injured. Hugh Young found only 129 cases amongst 179401 casualties (0.07 per cent). P. Macquet collected 2043 cases of kidney wounds representing only 0.2 per cent war wounds.

In his 73 cases Wallace found that in 34 (47 per cent) the kidney alone was injured the others were complicated by additional injury to the liver spleen or the hollow viscera. In some the thorax was also injured. Jocelyn Swan reported that 40 per cent of renal wounds reaching the base hospitals had concomitant injuries to the thorax. Gordon Taylor had 2 cases of left sided abdomino-thoracic wounds in which he successfully removed the left kidney and spleen. The most serious coincident injury is perforation of the colon colon wounds did notoriously badly.

Symptoms, signs, and treatment—On admission the majority of cases need resuscitation as in the serious civilian injuries. In the 1914-18 war blood



FIG. 98

Guns! wound of the kidney which has produced fragmentation  
(Dr. W. Calloun Stirling's case)

transfusion was in its infancy and could only be used in a few selected cases but in the 1939-45 one there were Mobile Resuscitation Units so the wounded had a better chance of recovery.

The same problems arise in war wounds as in civil injuries whether the



kidney is the only organ injured, or whether the chest or abdomen has been penetrated as well

In the case of a small entrance and exit wound in the loin with hæmaturia as the only symptom and no rigidity or other sign of intraperitoneal injury, then the case only needs watching. If one wound is in the loin and the other is in the hypochondrium then the loin wound should be excised, the kidney explored and dealt with according to the severity of the damage, the incision can then be carried forward and the peritoneum opened to enable the adjacent colon and other organs to be inspected. If a wound is in the loin and the other elsewhere in the abdominal wall, then there is almost a certainty of intraperitoneal injury. In these cases the loin wound should be excised and lightly packed with vaseline gauze, the patient should then be placed on his back and a laparotomy performed. It is essential to deal with the back wounds first as turning the patient over to deal with them after the laparotomy produces marked shock. The exploratory laparotomy should be very thorough, the whole of the hollow viscera from the stomach to the rectum being examined as gently and rapidly as possible. No perforations or tears should be dealt with till the whole has been examined as it is useless and a waste of time to repair small perforations and then a few inches away to find the gut so lacerated that a resection is indicated. The condition of the injured kidney may then be examined and dealt with by nephrectomy or in a few cases by repair. The liver or spleen may also be injured. If there is a concomitant chest wound it should be dealt with first if severe, and then the laparotomy, but if slight can be left alone and the laparotomy performed.

When there is only one wound then if possible an X ray should be taken. If the missile is seen in the abdomen then a laparotomy is necessary. But if the shell fragment is in the kidney then the wound should be excised, the fragment removed and if the kidney is not too seriously damaged, the wound packed with vaseline gauze. The insufflation of one of the sulphonamides may help to combat the sepsis.

In this connection it is interesting to note that Fullerton reported that 22 per cent of renal wounds, reaching the base hospital, developed secondary hæmorrhage necessitating nephrectomy.

About 50 per cent of the abdominal injuries which reached hospital and improved sufficiently to operate on, recovered the mortality being largely due to peritonitis sepsis or hæmorrhage. Whether the exhibition of the sulphonamides locally and orally will help us remains to be seen.

### AIR RAID CASUALTIES

Renal injuries in air raids are partly of the civilian type and partly resemble war wounds. The latter occur in firemen or A R P workers, and are due to bomb fragments. Those not engaged in these services take cover in shelters or houses. Their injuries are mostly the result of falling masonry, and therefore are of the crush type. During the heavy raids in the city and east end of London in 1940-41, 544 cases were sufficiently serious to require admission to the London Hospital. Of that number only five (0.9 per cent) had renal injuries: one was due to a bomb splinter and the other four to crush damage.

The bomb fragment caused a wound 3 in. long in the lower right thorax then passed on and lacerated the liver and the lower pole of the kidney, also fracturing two transverse processes. The patient was in very poor condition on admission but gradually improved, after transfusion with one pint of blood and three of plasma, sufficiently for operation to be performed eight hours

later The wound was excised and the lacerated area packed with vaseline gauze but the patient died the next day

Two of the crush cases had mild hæmaturia In one this was due to a fractured rib and cleared up in a few days One was admitted with slight hæmaturia and a severe compound fracture of his right forearm He was severely shocked on admission and by the time he had recovered sufficiently for interference he had developed massive gas gangrene of his arm He died and at post mortem he had a hæmoperitonæum and slight rupture of his spleen and left kidney

The fifth case was in a girl admitted with a fractured pelvis and profuse hæmaturia She was too ill for operation A self retaining catheter was inserted into her urethra in case the hæmorrhage was due to a ruptured bladder The hæmaturia ceased after ten days and the catheter was removed Later she developed a tender swelling in the region of the right kidney and a swinging temperature She was thought to have a perinephric abscess X ray showed a fractured rib her hæmaturia evidently coming from her right kidney, as cystoscopy showed a normal bladder Later she passed a large quantity of pus in her urine and the swelling disappeared On recovery a pyelogram showed a normal kidney

The disappointing feature in these severe air raid casualties was that although they reached hospital a very short time after injury in comparison with war casualties few of them responded to the various forms of resuscitation and transfusion The pulse rate was no true guide to improvement An improvement in the blood pressure appeared to be the best guide to recovery

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## CHAPTER IX

### HYDRONEPHROSIS

**T**HE term signifies a state of dilatation which involves either a part or the whole of the kidney.

#### PATHOLOGICAL ANATOMY

The fact that in many slight cases the pelvis only is involved, suggests that the dilatation often begins in the renal pelvis. When the expansion is



FIG. 29  
Intravenous pyelogram showing well marked pelvic  
hydronephrosis.

limited to the pelvis, or the involvement of this portion of the kidney is an outstanding feature of the change, the condition is referred to as a pelvic hydronephrosis.

Sometimes the dilatation is part of a process which involves a varying extent of the urinary tract below, and even the upper urinary tract on the other side.



FIG 30

Hydronephrosis due to in-  
adequate ureteropelvic opening.  
The latter would admit only the  
bit here seen in position.

dilatations in particular namely, where normality ends and abnormality begins

*Microscopically* in the early cases there is definite muscular hypertrophy. It becomes apparent however that as the dilatation of the pelvis increases, so the muscular elements of the pelvic wall are gradually replaced by fibrous tissue. Different degrees of inflammatory change (pyelitis) are constantly present. This was seen to be so in microscopic sections from eighteen cases which the writer examined and in all cases where the adjacent ureter was also microscopied this was found to be the seat of the same change.

*The parenchyma*—As the calyces gradually participate in the dilatation not only do the papillae slowly become flattened but this thinning process from pressure extends more and more to the rest of the renal substance (Fig 30). The generalized expansion of the organ may proceed so far as to result in a large palpable tumour with a lobulated surface and with the renal substance replaced by a thin shell of fibrous tissue. The pelvis in these circumstances

The dilatation of the pelvis may be so slight that it is debatable whether there is any dilatation present at all. From this minimal state onwards there occurs every degree of distension up to a condition where the kidney is expanded into an enormous sac which visibly distends the upper part of the abdomen.

*The renal pelvis*—In the early stages of hydronephrosis it is interesting and important from a practical point of view to recognize that different types of dilatation may occur. These are obvious from observations by intravenous urography: a small calculus in its progress down the ureter will cause dilatation which involves uniformly the calyces and the renal pelvis. The same tendency is apparent in the renal dilatations of pregnancy. An early pelvic hydronephrosis on the other hand shows the renal expansion to be confined to the pelvis alone (Fig 29) and it is not till later on that the calyces share in the expansion. An obviously difficult although a somewhat academic point there fore sometimes arises in connection with pelvic

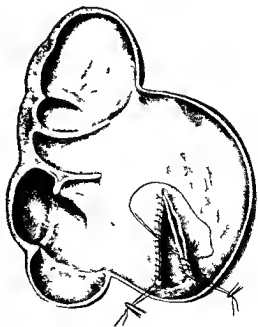


FIG 31

Diagrammatic representation of a plastic operation to overcome obstruction from kinking and adhesion to pelvis of upper ureter. The latter structure runs upwards from the ureteropelvic junction and together with the overlying pelvic wall has been divided.

also forms a sac of considerable size (Fig 31) Such a kidney may contain several pints of fluid

There may be a condition of partial hydronephrosis, in this, only a group of calyces is involved and the pelvis does not share in the dilatation, this condition is also referred to as hydrocalycosis (Fig 32)

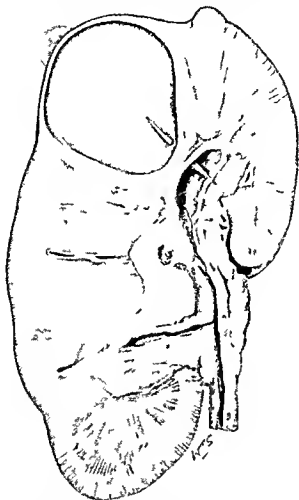


FIG 32

**Hydrocalycosis** The cyst apparently represents the uppermost group of minor calyces. The pointer passes through the only and inadequate opening into the upper main calyx. Woman aged 58 with hæmaturia for three months

*On section*—The renal substance of a hydronephrosis is found to be reduced in depth, and in extreme cases replaced entirely by fibrous tissue. In the latter circumstances the organ consists of a series of fibrous pouches which represent the calyces, and which have enlarged at the expense of the papillæ which have completely disappeared from back pressure. The pouches are separated by fibrous walls, and open by constricted orifices into the main calyces.

*On microscopical section*—Appearances vary according to the degree of dilatation reached. There is progressive expansion of the tubules, which

extends in a retrograde manner from the straight tubules through the convoluted tubules and even in some cases to the glomeruli. The epithelium of the pelvis and calyces undergoes a change from transitional to cubical or stratified. The interstitial tissue at first the seat of an oedematous infiltration slowly becomes fibrosed. The appearances in the advanced condition show thickening of the true capsule atrophy and sclerosis of the glomeruli and of the capillary network round the Bowman's capsules which show signs of cystic dilatation dilated segments of tubules sclerosis of blood vessels and an extensive replacement of specialized elements of the kidney by fibrous tissue. In the final stage there remains only a thin fibrous shell throughout on which numbers of small cysts are to be seen.

The fluid in the hydronephrosis contains the substances found in urine but in a small concentration which is progressively less as the disease advances.

The blood-vessels of the hilum as the condition advances become separated flattened out and the arteries become atrophied. (See also Blood vessels as a cause of hydronephrosis.)

The large bowel, which normally lies in front of the kidney becomes displaced medially when a considerable stage of dilatation is reached.

The ureter.—The hydronephrosis may or may not be associated with dilatation of the ureter. When dilatation is present the ureter may reach the calibre of the small intestine or become even larger. Above the ureter is continuous with the pelvis but separated from it by a narrow neck which marks the junction between ureter and pelvis. The wall of the ureter undergoes the same change as the pelvis. According to the level of the ureter at which an obstruction is situated so a greater or lesser part of the ureter is involved in the dilatation. The ureter is not only dilated but is also lengthened as indicated by tortuosities at different levels.

The dilatation of the ureter is often present quite independently of any obstruction. It occurs sometimes as an accompaniment of pelvic dilatation even when the obstruction which appears to be causing the renal dilatation is situated at the ureteropelvic junction. When the hydronephrosis is caused by an obstruction to the ureter it may be due to a compression a stricture a narrowing of the vesical orifice of the ureter or an obstruction caused by a stone or a tumour.

When the ureter is not dilated there is often a modification of the outlet from the pelvis into the ureter for instead of being at the most dependent part of the pelvis the opening may be at a higher level and have quite a valve like arrangement. Sometimes this results from the fact that the upper end of the ureter is adherent to the outer aspect of the pelvis for a certain length. Any of these changes results in an obstruction to the outflow from the pelvis.

The opposite kidney.—This may be affected in the same way in other words there is bilateral hydronephrosis. In the majority of cases however the condition is unilateral.

### ÆTIOLOGY

Hydronephrosis may be congenital or acquired.

**Congenital hydronephrosis**—Most of the cases occurring in early life are congenital.

**THE HEREDITARY FACTOR**—This also plays a part. Blackwood (1895) refers to the reported case of a woman who gave birth to three premature children each with a hydronephrosis.

**ASSOCIATED WITH CONGENITAL ABNORMALITIES OUTSIDE OF THE URINARY TRACT**—There may be present such conditions as spina bifida or imperforate anus.

**SUPERVENING FROM A CONGENITAL ABNORMALITY OF THE URINARY TRACT**—The resulting renal dilatation, often slow in developing, is only rarely to be noted at birth or in early childhood. The causal malformation may be merely a severe phimosis, an atresia of the external urinary meatus or a urethral stricture, nearly always, however, the obstruction to the urinary flow is in the course of the ureter, as, for example, from stricture, especially just below the

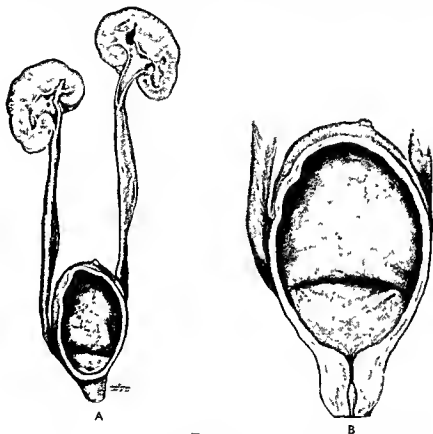


FIG 33

A, Idiopathic dilatation involving kidney, ureters and bladder. The sectioned urethra B, does not indicate that this stricture took part in the dilatation. Post mortem specimen from a male of 6 months

pelvis; valves, an abnormal situation for the opening of the lower end of the ureter, be it in the urethra, the bladder, vagina, rectum or elsewhere; or there may be an abnormal course of the ureter because of the presence of ectopia vesicæ.

Opening of the ureter from a position high up on the wall of the pelvis is also commonly cited as a cause. This state of affairs, however, is an acquired rather than a congenital lesion; for obstruction to the outflow of urine results in the distension of the lower part of the renal pelvis, and causes the uretero-pelvic junction to be slowly raised above the most dependent part of the pelvis. There is one associated condition which is of outstanding importance in connection with congenital hydronephrosis, namely, dilatation of the whole ureter together with the renal pelvis. This may be due to a stricture

at the vesical orifice of the ureter which in due course gives rise to a ureterocele, or on the contrary there may be a gaping ureteric orifice which shares the general dilatation above it. This in its turn may also be associated with dilatation of the bladder itself. It seems that the dilatation (Fig 33) which may involve a different extent of the urinary tract according to the case is the primary fault in many cases of hydronephrosis.

Hydronephrosis as a part of a more widespread malformation of the kidney is not uncommonly found horseshoe (Fig 34) double and ectopic kidney are the abnormalities which occur most often with this association. There is



FIG 34

Instrumental pyelograms of a horseshoe kidney with bilateral hydronephrosis in a man aged 50 (Mr S G MacDonald's case)

generally no obvious reason why the two conditions should occur together. In the case of horseshoe kidney the ureters generally pass in front of the connecting band of renal tissue so it is not a question of pressure from this.

Aberrant blood-vessels as a cause of hydronephrosis are fully discussed on p 91.

**Acquired hydronephrosis**—This results from disease or injury which causes obstruction to the outflow of urine from the kidney. The initiating lesion may be seated anywhere in the urinary tract between the preputial orifice and the kidney. Obstructions in the lower urinary tract will involve the upper on both sides. In these circumstances nevertheless, the dilatation is often more advanced on one side than the other.

A DIMINUTION OF THE CALIBRE OF THE URETER explains the majority of cases which may arise from a variety of causes: a calculus or a growth within the lumen of the ureter; compression by tumours of the true pelvis, especially carcinoma of the uterus and the broad ligament; encirclement by





FIG 35

Intravenous urogram showing right-sided hydronephrosis same case as Fig 36

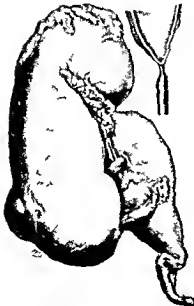


FIG 36

Hydronephrosis resulting from constriction and kinking of the uretero-pelvic junction Same case as Fig 35

# HYDRONEPHROSIS

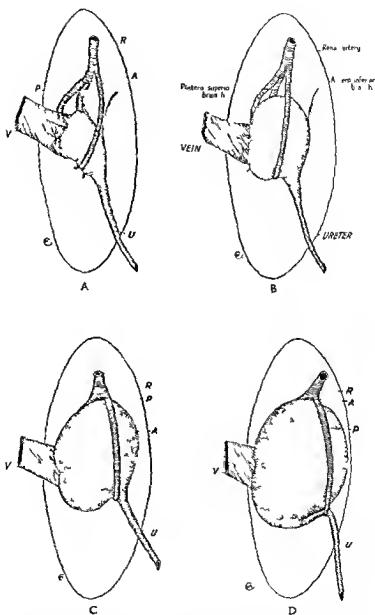


FIG 37

Diagrammatic medial views of a series of right renal lula. The renal vein has been turned forward to show the changing relationships between the pelvis inferior branch of the renal artery and the ureter during the process of pelvic distension. R renal artery A anterior inferior branch P postero superior branch V vein U ureter. It can be seen how the distending pelvis as it pushes forwards over the inferior branch of the renal artery drags with it the ureter which becomes compressed between the pelvis and the artery causing the last structure to be behind instead of in front of the pelvis.

periueteral fibrous tissue resulting from extravasation of urine, or a simple inflammation stricture of the ureter (Fig 36) which may be inflammatory or traumatic in origin. The former often results from a stone which has rested for a considerable time at one place in the ureter, the latter from operations on the ureter or from panhysterectomy.

IN THE RENAL PELVIS certain calculi non branched rather than branched, produce hydronephrosis papillomata give rise to haematonephrosis.

INFLAMMATION—In considering this as an aetiological factor we have to keep two principles of pathology in mind early chronic inflammation of the renal pelvis and ureter commonly results in dilatation of these structures, the fibrosis which in due course supervenes from chronic inflammation is a potential factor in causing obstruction from the outlet of the pelvis. Microscopical examinations of the ureteropelvic junction which I have been able to

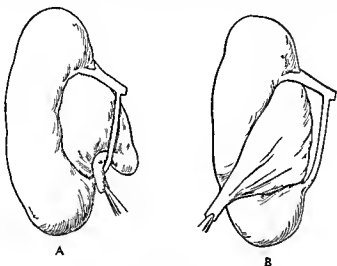


FIG 38

A Posterior view of a nephrectomy specimen showing a left hydronephrosis in which the dilated pelvis has pushed forward dragging the ureter with it over the inferior branch of the renal artery.  
B The pelvis has been drawn backwards leaving the artery in its original position in front of the pelvis.

make in a number of early cases of pelvic hydronephrosis all showed chronic inflammation to be present. Moreover the puzzling state of affairs in which there is a long history of attacks of pain in an early case of hydronephrosis is explicable on the grounds that the symptoms were at first due to inflammation and later to hydronephrosis or to both of these causes. There are certain clinical facts which also point to inflammation as an aetiological factor, hydronephrosis is twice as common in women as in men. This is significant when it is recalled that pyelitis (pyelonephritis) is much more common in females than in males.

MOVABLE KIDNEY—This may be considered a rare cause of hydronephrosis. The fact that the two conditions are sometimes found together has no doubt led to confusion. Hydronephrosis undoubtedly gives rise in certain cases to increased mobility from the stretching which occurs of the surrounding attachments of the kidney. Experimentally it has been proved impossible to cause hydronephrosis by merely producing mobility of the kidney (Tuffier 1893). A number of observers (Legueu 1896 1904) have demonstrated that the upper ureter must be fixed in order to produce obstruction by kinking. In certain

early cases of hydronephrosis there is undoubted benefit from nephropexy when the kidney is fixed in a high position

**TRAUMATISM OF THE KIDNEY** is often misrepresented as a cause of hydro-nephrosis. There are two reasons for this—a pre-existing hydronephrosis is sometimes shown up by an injury, a large fluid swelling which develops in the renal region as a result of a renal injury is generally due to an extravasation of urine outside of the kidney—a pseudo hydronephrosis. Only as a late result of a renal injury could hydronephrosis develop namely, from sclerosis affecting the outflow from the pelvis

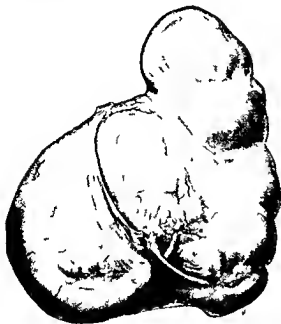


FIG 39

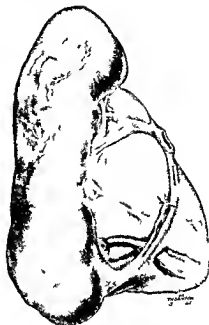


FIG 40

FIG 39 Nephrectomy specimen of advanced hydronephrosis. It has been dissected to show that the ureter is compressed and obstructed by the overlying artery and vein, and that the proximal portion of the ureter is slung within and supported by the renal (urogenital) fascia

FIG 40 Nephrectomy specimen of advanced hydronephrosis. It has been dissected to show that the ureter is compressed and obstructed by the overlying artery and vein. A vent has been made in the renal fascia over the proximal portion of the ureter to show a similar relationship as depicted in the preceding figure. Apparently the renal pelvis when it was much smaller moved forward through the gap between the superior and inferior branches of the renal vein

V renal vein with its normal superior and inferior branches

**Blood-vessels as a cause of hydronephrosis** (the so called aberrant vessels)  
—Compression of the ureter between the pelvis and a blood vessel is a common finding in connection with hydronephrosis. There is no doubt that the degree of obstruction to the outflow of urine caused by the blood vessel is often severe. In an advanced case the offending blood vessel lies across the back of the pelvis (Figs 37 to 42). As there is normally no blood vessel in this situation, the belief has arisen that the vessel is an aberrant one and that this is the original cause of the hydronephrosis. The following facts have been demonstrated however—that the compression of the ureter by the blood vessel is a complication and not the primary cause of the hydronephrosis, that the

blood vessel itself is not aberrant but the normal inferior branch of the renal artery or vein which originally lay in front of the pelvis in passing between the main renal vessel and the lower part of hilum of the kidney that the relationship of the various structures to one another becomes altered as a result of pelvic expansion. It is only if the gap between the superior and inferior branches of the renal vessels is large enough to admit the renal pelvis as it moves forward in the early stages of its expansion that compression of the ureter by a blood vessel is possible. The gap is of course largest when

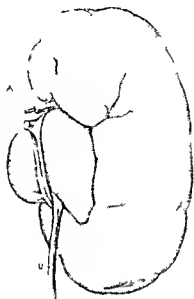


FIG 41  
Posterior view of a right hydronephrosis showing compression of the ureter by the normal inferior branch of the renal artery. A artery V vein U ureter

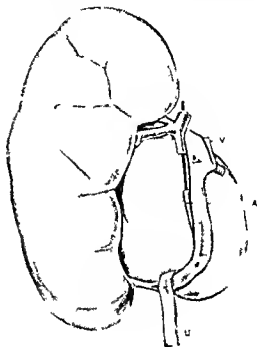


FIG 42  
Posterior view of a left hydronephrosis showing a looping of the ureter over the normal inferior branch of the renal vein. V vein A artery U ureter

the inferior branch of the renal artery rises directly from the aorta.

The vessel in such circumstances may be properly described as aberrant (Fig 43). After the pelvis has moved forward into this space if the pelvic dilatation continues sufficiently far the pelvis may pass right through dragging with it the upper part of the ureter which must inevitably be compressed between the lower blood vessel and the pelvis (Figs 41 and 42). The final state of affairs in an advanced case shows an enormous pelvis with a blood vessel in contact with its posterior surface against which the ureter is pressed (Fig 40). It is interesting to note that the vein and not the artery may cause the compression (Figs 41 and 42).

In an advanced case where the ureter is being compressed by a blood vessel it is important to realize that the pelvis and ureter move forward in the sheath of fascia which normally surrounds them—the renal or urogenital fascia. This sheath may exercise a considerable constricting influence on the ureter in these circumstances (Figs 39 and 40).

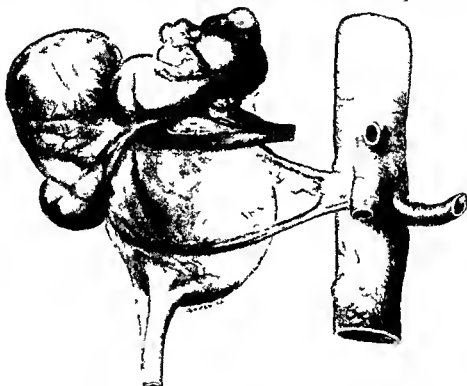
This subject has been discussed in detail by the author in previous publications (1925 and 1936).

## PATHOLOGICAL PHYSIOLOGY

According to the behaviour of a hydronephrosis it is convenient to consider the terms open, closed and intermittent

**Open hydronephrosis**—The concentration of urea and of salts becomes progressively less in the urine and the renal tissue tends to disappear, until finally only the merest traces are to be found

The course of events is not the same in the hydronephrosis which develops rapidly as when it develops slowly In the former case complete atrophy



110 43

A post mortem specimen showing the front view of a right hydronephrosis and the aorta giving rise to an aberrant renal artery. The latter cannot be said to be playing any part in causing the hydronephrosis

supervenes quickly and the kidney does not attain a very large size, in fact, the kidney on ceasing to excrete tends to disappear. In the latter case the kidney may attain a considerable size

**Complete closure of the ureter** does not lead to hydronephrosis, the outstanding change which occurs is atrophy of the kidney. But when retention supervenes gradually upon a partial obstruction the urine loses all its urinary characters and contains only albumen and sometimes cholesterol

**Intermittent hydronephrosis**—The term arises from the fact that undoubtedly there are sometimes discharges of large quantities of urine from a hydronephrosis over a short period of time alternating with periods when little or no urine is passed from the kidney in question. For many years these phenomena were interpreted as representing alternate phases of non obstruction



Fig 45  
Kidney opened after hardening  
shows abscess of parenchyma  
(bulging surface in lowest third),  
and vermiform masses of clot in  
pelvis and uppermost calyces  
Same specimen as Fig 36



Fig 46  
Kidney opened immediately after removal shows well  
marked hemorrhagic pyelitis Nephrectomy for bleeding  
in hydronephrosis Same case as Fig 47

## SYMPTOMS AND SIGNS

The disease is twice as common in women as in men and the symptoms in the majority of cases have their onset in the third decade of life. Some cases of hydronephrosis remain *latent* and reach the stage of complete atrophy without producing any local symptoms. Sometimes a long latent period is succeeded by symptoms indicating that infection has supervened. Other cases give rise only to occasional vague pains in the lumbar region.



FIG 47

Intravenous urogram showing well marked generalised hydronephrosis (See Fig 46)

A large tumour in the loin may be the chief sign. In exceptional cases it may visibly distend the abdominal wall. The pain preceding the development of such a tumour is generally slight often amounting to no more than a sense of weight in the lumbar region. Repeated observations may show a tumour which is gradually increasing in size or one which varies in size and consistency as indicated by palpation. Diminution in size will generally be accompanied by a disappearance of pain and an increased evacuation of urine.

Pain is the sole feature in some cases. There may be a constant or an intermittent ache in the loin but attacks of colic are common.

When the pain is not so acute as to cause boarding of the overlying muscles it may be possible to note that an increase in pain is accompanied by an increase in size of the kidney. As a rule however the contraction of the overlying muscles does not permit of this observation. A phase of *oliguria* often corresponds with the more painful period of the attack and is followed in due course by *polyuria* and a lessening of the pain.

**Increased frequency of micturition** occurs commonly with the attacks of pain. This is due to two causes: *polyuria* and to a common involvement of the kidney and the bladder in the inflammation.

**Hæmaturia** from hydronephrosis is fairly common and results from nephritis or from more obvious inflammation. The enlarged pelvis and calyces become filled with blood and constitute a hæmatonephrosis. The hæmorrhage may be the means of calling attention to the presence of a hydronephrosis (Figs 45 and 46). Renal calculus is sometimes a direct consequence of the hydronephrosis (Fig 48).

**Toxic symptoms** in the form of loss of weight, headaches, lassitude, anemia, hyperpæsiæ etc. are often a feature of advanced cases. These features doubtlessly result from reabsorption from the obstructed kidney.



## COURSE AND COMPLICATIONS

The course of the disease may extend over many years and is one of slow but progressive dilatation of the kidney. Clinically the manifestations of the disease are commonly intermittent. Usually there are attacks of colic which are at first at long intervals often of many months but as the disease progresses the attacks become more frequent and more severe. Over the course of years the general health of the patient tends slowly to suffer with the onset of headaches, often indigestion and some loss of weight. It is from the possibility of complications that the real danger lies of these infection is the most important. When the latter occurs the urine is changed from clear to turbid and the pain becomes a more prominent feature while disturbances of temperature set in and the size of the tumour is increased.

Anuria invariably indicates that there is also disease of the opposite kidney. Sometimes the disease of this organ appears to be only slight in these circumstances it is probably influenced by the toxæmia caused by the obviously pathological organ. Anuria is sometimes the result of hydronephrosis in a solitary kidney.

Rupture of a hydronephrosis can occur spontaneously but is generally the result of traumatism. There is extravasation of urine into the perinephric tissue giving rise to a pseudo hydronephrosis. More rarely the rupture occurs into the peritoneum an interesting account of such an accident was reported by Milnes Walker (1933). Rupture has been known to occur actually on to the skin surface. Obviously the intraperitoneal rupture is a serious complication and recovery from it will depend on prompt recognition and intervention.



FIG. 48

A nest of small stones which have formed secondarily to a pelvic hydronephrosis. The kidney was removed by operation from a child.

## DIAGNOSIS

The presence in the loin of a large tumour which is soft, movable and varies in size from time to time is diagnostic of a hydronephrosis. Many cases however lack these features and in some no swelling is palpable at all.

Pyelography is the one certain means of diagnosis which should be used in all cases not only to see the full extent of the dilatation on the diseased side but also to ascertain the state of the other kidney.

Intravenous urography should always be employed in the first instance and only if the results from this method are considered inadequate should the instrumental method be employed. There is always the danger from the latter method of stirring up infection. With the former method when the functional activity of the kidney has been much reduced in order to get a film showing the full extent of the dilatation it may be necessary to make exposures up to several hours after the injection has been made. Excellent pictures have been ultimately obtained by waiting for three, four and even six hours after the injection.

Exceptionally this routine has not proved adequate making it necessary

to carry out *instrumental pyelography* in due course. On passing the ureteric catheter after noting the full distance that it has passed, as much urine as possible should be extracted with the syringe, carefully measured and kept for laboratory investigation. A large quantity of urine will, of course, indicate a corresponding degree of hydronephrosis, but the amount extracted does not necessarily indicate the full extent of the renal retention.

If there is no complaint of pain after the injection of 20 c.c. of opaque medium, a film should be exposed which will give some idea of the state of affairs and if appearances suggest a greater capacity, more fluid should be injected and further films exposed until a satisfactory picture is obtained. A dilated ureter is often displayed in this way, or it may be necessary to withdraw the tip of the catheter a few centimetres down the ureter before the injection is made. At the end of the examination as much of the injected fluid as possible should be extracted. Sometimes in spite of a well-developed hydronephrosis it is impossible to withdraw any fluid. This is generally because there is an obstruction which prevents the tip of the catheter from entering the pelvis. In these circumstances acute infection of the kidney is likely to follow. When it is necessary to carry out instrumental pyelography on both sides and there is reason to believe that both kidneys are diseased, it is wise to allow an interval of at least seven days to elapse between the two examinations. All signs of reaction from the first pyelography should have disappeared before the second is undertaken.

Patients should always be kept in bed after instrumental pyelography sufficiently long to allow any reaction that may occur, to pass.

**THE INTERPRETATION OF THE PNELOGRAMS**—In considering the slighter degrees of dilatation it is a point of more than academic interest to decide which appearance indicates a normal and which indicates a slightly dilated pelvis. It is impossible to draw a clear line of demarcation between the two; one merges so imperceptibly into the other. Commencing from the doubtfully dilated pelvis there is a succession of gradually increasing dilatations which in due course also involve the calyces, and are finally represented by the well known enormous expansion of the whole kidney. Fig. 18 may be regarded as pelvis in the undilated state, while Fig. 364 represents an increased degree of dilatation. Sometimes the earlier films in a series of excretion urograms will not outline the pelvis at all, but merely show a series of circular areas indicating dilated calyces; such appearances are clear evidence of the existence of a hydronephrosis; later films in the series will usually show up the full extent of the dilatation.

### PROGNOSIS

The patient's life becomes urgently endangered from hydronephrosis only when the latter ruptures into the peritoneum. When both kidneys are affected there is a considerable shortening in the expectation of life.

As far as the outlook for the affected kidney is concerned the longer the disease exists the greater is the destruction of the organ, and the more its functioning capacity is reduced.

Infection may lead to systemic infective complications or perinephric abscess, and suddenly create a grave prognosis.

### TREATMENT

This is conveniently considered under two headings: uretero-hydronephrosis, simple hydronephrosis.

**Uretero-hydronephrosis**—THE CAUSE IS REMOVABLE—This is possible in such conditions as stricture of the urethra hypertrophy of the prostate, bladder neck disease, ureterocele stone a simple bladder growth at the ureteric orifice. A malignant bladder growth at the ureteric orifice, which is removable, accompanied by division and re implantation of the ureter into the bladder, must also be placed in this category.

There are causes outside of the urinary tract such as fibroma of the uterus, ovarian tumours, bands of tissue, etc.

**DILATATION WHICH CANNOT BE REMEDIED**—This may occur from certain malignant bladder growths, especially in the vicinity of a ureteric orifice, when associated with congenital dilatation of the ureteric orifice, in the presence of new growth of the ureter. Outside of the urinary tract, inoperable pelvic tumours may obstruct the ureter. Nephrostomy in the last type of case is rarely justifiable for the relief of back pressure on the kidneys and its consequences.

**Simple hydronephrosis**—**NEPHRECTOMY** is the treatment of choice when the opposite kidney is sound and the diseased organ is disorganized, or the dilatation of the calyces has progressed so far that they will continue to lodge pools of residual urine, for such a degree of dilatation will inevitably maintain any infection which supervenes.

**NEPHROSTOMY** is often the best procedure to carry out when the opposite kidney is not healthy. It is sometimes gratifying to see the way in which a badly damaged kidney will resume a good standard of functional activity following nephrostomy. In certain bilateral cases the best prognosis is offered by establishing this form of drainage on both sides. The procedure is also essential when plastic measures have been carried out in advanced cases and may require to be continued for many weeks. Should the loin fistula fail to close after removal of the tube, there remains the choice between permanent nephrostomy and nephrectomy.

**PLASTIC OPERATIONS** for reducing the size of the renal pelvis are called for in early cases. The simple procedure of excising a portion of the enlarged pelvis, and if necessary combining this with a measure for enlarging the lumen of the ureteropelvic junction, gives good results. The latter step is carried out by making an incision in the long axis of the channel, after a large sized ureteric catheter has been passed into the renal pelvis from below. The incision is left unsutured and the catheter remains in position for ten days or more.

In cases where the hydronephrosis is advanced and yet the kidney must be preserved, and there is objection to a permanent nephrostomy, a more elaborate plastic operation must be performed.

In these circumstances it may be necessary to sever the ureter from the pelvis and after reducing the size of the latter to re implant the ureter into it. The results of this type of operation are uncertain and often bad, and therefore it is wise to discuss fully the outlook as compared with that from nephrostomy with the patient before undertaking it.

**DIVISION OF BLOOD VESSELS OBSTRUCTING URETER**—A careful inspection of the ureteropelvic junction when the kidney is exposed will sometimes show that the ureter is compressed between a renal blood-vessel and the renal pelvis. Whatever was the original cause of the hydronephrosis, division of such a vessel will reduce the obstruction and relieve the patient's symptoms although subsequent careful pyelograms will generally show that some degree of hydronephrosis is still present. The constricting vessel is usually either the artery or vein which normally passes in front of the pelvis between the lower margin of the renal hilum and the main renal vessels. It is often wrongly described

as an abnormal vessel. If it is the artery which is divided there is the risk of causing necrosis of the lower pole of the kidney. This can be avoided by excising the lower pole of the kidney at the same time. It is important to be sure whether or not two vessels are taking part in the obstruction. Sometimes the pelvis and ureter have moved so far forward inside the sheath of fascia in which they lie (Figs 39 and 40) that division of vessels is inadequate and the sheath must also be divided.

**NEPHROPEXY** is likely to succeed as a measure of relief only in cases with a slight degree of dilatation and a considerable degree of mobility of the kidney. The kidney should be fixed in the highest possible position after freeing any adhesions which may be present in the region of the ureteropelvic junction.

**Hydronephrosis associated with congenital malformation of the kidney**—This is seen in such conditions as double kidney ectopic or horseshoe kidney and generally requires nephrectomy. In certain rare cases of horseshoe kidney it may be justifiable to expect improvement from the relief of pressure on the ureter by dividing the isthmus of tissue which connects the two kidneys.

**Renal sympathectomy**—(See p 136.)

**Operations for hydronephrosis**—**NEPHRECTOMY**—When the tumour is very large it may be advisable to reduce its size by puncture and drainage with a trocar and cannula. The instrument should have a large bore. The site for puncture is chosen about the middle of the posterior border. The surrounding wound should be packed off with a roll of gauze and as the puncture is made a receiver is placed in position to catch the escaping fluid. After withdrawal of the trocar the cannula should be pushed well in so that it reaches the pelvis. By gently kneading the organ as the evacuation proceeds complete emptying can be attained. When the cannula is withdrawn the wound may be completely sealed by seizing the organ well back from the wound edge with a pair of Duval forceps. If perinephric adhesions are marked from old standing sepsis a subcapsular nephrectomy may be imperative. For details of this procedure see p 160.

**NEPHROSTOMY**—It is important that the nephrostomy tube lies in the renal pelvis. The best method of assuring this is to make a small incision in the posterior wall of the pelvis and to insert the outer end of the tube through this and then pass it through a selected point on the outer border of the kidney. An adequate exposure of the posterior aspect of the renal pelvis is made. A self retaining suprapubic tube is taken and its outer end cut obliquely so that it becomes pointed. A stout thread is fixed to the tube near the point by one end and by the other through the eye of a probe. The site for the incision into the pelvis is chosen and surrounded with gauze. The pelvis is incised just sufficiently to admit the tube. The unattached end of the probe is passed through the pelvic incision and out through the point selected on the outer border of the kidney. As the probe is passed through the kidney the thread and then the tube are also drawn through until the expanded end of the tube is placed in the middle of the pelvis. This technique causes the renal tissue to fit tightly round the tube so that no bleeding results. If for drainage purposes it is necessary to incise the kidney widely this method is not applicable. The tube must then be adjusted through an incision in the outer border and made to fit snugly by sutures. The tube is secured to the renal substance by a fine catgut thread. After removing the packing and stitching the loin wound up the tube is secured to the skin edge where these two structures are in contact. It is an advantage if it can be arranged that the tube emerges from the parietal wound towards the front rather than the back. The tube should be drained into a bottle fixed to the side of the bed and left undisturbed.

for two weeks. At the end of this time it may be replaced by the permanent nephrostomy tube which must be all ready to place in position the moment the other one is withdrawn. A careful measurement of the distance between the inner end and the site of transfixion of the tube by the skin suture is made and the permanent tube adjusted to this length in the shield which retains it and the tube is then inserted without delay. A waist belt which secures the tube in position supports a rubber bag into which the urine drains. The belt in its turn is secured by a shoulder strap and two thigh bands (Fig. 433).

**SIMPLE PLASTIC OPERATIONS ON PELVIS**—After exposing the kidney it is necessary to completely free the pelvis by dissection from surrounding tissue and structures taking care at the same time to free any adhesions between the pelvis and the ureter. With scissors a strip which may be curved or angled according to requirements is then excised from the lower border of the pelvis. In doing this it is necessary to see that the incision does not approach nearer than half an inch to the renal hilum or the ureteropelvic junction. Disregard of this necessity may create difficulty in suturing the pelvis and give rise to scar tissue so close to the pelvic outlet as to create an additional obstruction.

The pelvic wound should be restored with interrupted Lembert sutures of fine plain catgut threaded on to small half circle reversed Hagedorn needles. A drain of corrugated rubber should be fixed to the suture line and left in position for at least seven days or if there is an escape of urine until this has ceased to flow when the drain is gradually shortened from day to day.

**SIMPLE INCISION OF URETEROPELVIC JUNCTION**—Pyelographic observation may indicate a stenosis at the pelvic outlet in an early case. Operative treatment for this should be preceded by the passage of as large a size as possible of ureteric catheter beyond or up to the stenosis. After exposing the kidney the pelvis and adjacent ureter are carefully isolated. If necessary any redundant pelvis is excised. A longitudinal incision of about half an inch in length is then made through the stenosed zone and the ureteric catheter adjusted so that its tip lies well in the pelvis. If any pelvic tissue has been excised the pelvis is re-sutured as already described but the incision through the stenosis is left open with a rubber drain sutured to the outer aspect of the site. The ureteric catheter is left in position for ten days.

**NEPHROPEXY**—(See p. 66)

**DIVISION AND RE-IMPLANTATION OF URETER INTO REDUCED PELVIS**—The posterior aspect of the pelvis is fully exposed and isolated from the rest of the wound by gauze packing. A traction suture is placed on either side of the line of the intended incision which is through the middle of the pelvis from above downwards towards the ureteric opening. All the sutures which transfix the kidney or ureter in this operation are of fine plain catgut mounted in small half circle Hagedorn needles. The incision into the pelvis should be  $1\frac{1}{2}$  in long. By maintaining tension on the traction sutures the urinary contents of the pelvis are prevented from escaping into the wound. The urine is carefully removed by mopping with small swabs held in forceps. Gum elastic bougies of sizes from about 5 to 7 English are passed through the opening and down the ureter for the purpose of dilating any constriction that may be present. A rubber catheter size 7 English in which a single lateral opening has been cut so that it will drain the renal pelvis is passed for 10 cm. down the ureter. With a pair of scissors the ureter is completely separated from the pelvis at the junction of these two structures as a continuation of the original pelvic incision. A single suture is passed to include one wall of the catheter and the margin of the ureter in its long axis. A pair of curved long bladed forceps is passed along the inferior main calyx and through the renal substance

by way of one of the corresponding minor calyces. The forceps are made to grip the point of another pair of forceps which is then drawn into the renal pelvis. The blades of the latter instrument grasp the free end of the catheter and draw it along the route the forceps had just traversed in the reversed direction so that the catheter is left projecting through the puncture wound in the renal tissue. Some surgeons prefer to drain the pelvis with an extra tube which passes outwards through the renal substance. The catheter is then fixed to the true renal capsule by a suture so that about half a centimetre of the ureter is left projecting into the renal pelvis. The lower margins of the pelvic incision are fixed by a solitary suture to the wall of the ureter that lies in apposition with it. The remainder of the pelvic incision is closed by a series of interrupted Lembert sutures. The first of these includes the wall of the ureter. A corrugated rubber drain is fixed to the lower end of the pelvic incision. The whole suture line is buried by drawing together the overlying fibro fatty tissue with several interrupted sutures. The catheter and the drain are allowed to project together from the loin wound as this is sutured. The drain is removed at any time after the seventh day that the temperature is settled and the catheter on the fourteenth day.

**PARTIAL NEPHRECTOMY FOR HYDRONEPHROSIS**—This operation is applicable to a case of a kidney with a double pelvis one part of which is hydro-nephrotic. After the kidney is exposed the ureter corresponding to the dilated portion of the kidney is identified clamped divided and ligated. A careful dissection of the vessels of the renal pedicle is then made and the vessels connected with the hydronephrotic portion are identified ligated and divided. The kidney is next packed off from the wound with gauze. By using scissors the dilated portion is quickly separated from the healthy renal substance. If the atrophy of the diseased portion is considerable the separation can be accomplished without any bleeding at all. If bleeding does occur it is easily controlled by mattress sutures of stout plain catgut passed on a round bodied needle. A corrugated rubber drain is stitched to the site of section and left in position for several days.

**ANASTOMOSIS BETWEEN PELVIS AND URETER**—It is in bilateral cases where the dilatation is considerable and when an obstruction exists between the pelvis and the ureter that such operations as the following are justifiable—

*From inside the pelvis*—The pelvis is opened the pelvic opening into the ureter is sought and found one blade of a pair of fine pointed scissors is passed into the orifice and along the ureter which is then slit up into the pelvis the adjacent cut edges of the ureter and pelvis are then sutured in the manner depicted in Fig 31.

*From outside the pelvis*—Portions of the pelvis and ureter which are conveniently adjacent are isolated incised and anastomosed with continuous catgut sutures.

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## CHAPTER X

### CYSTS OF THE KIDNEY

**T**HERE are only two cystic conditions of the kidney which are of surgical importance these are the so called solitary cyst and polycystic disease. Cysts of the kidney are also found in hydatid disease. They are very common in chronic nephritis but surgery is not concerned either in their diagnosis or treatment. Dermoid cysts are very rare. Haemorrhagic cysts occur which are obviously due to degeneration in parts of neoplasms. In other instances there is a unilocular cavity containing blood or clot and on one portion of its wall a small nodule of tumour is present. This chapter is devoted to the discussion of solitary cysts and congenital cystic disease of the kidney.

#### SOLITARY CYSTS

The term solitary cyst should literally include every condition in which a single cyst exists in the kidney but it is used for want of a better name to describe a cyst formation which by giving rise to local symptoms and thus calling for investigation of the kidney not infrequently demands operation. Though such a cyst must have a small beginning it is not until it has attained a certain size that it attracts attention and therefore another name used is *large solitary cyst of the kidney*. However though usually single there are sometimes two or three of them and a similar cyst is occasionally present in the opposite kidney. Most often when found by the surgeon the cyst is of a size varying between a tangerine orange and a tennis ball. Such formations are also spoken of as serous cysts.

**Incidence**—Solitary cysts are uncommon. Fish (1939) found 32 cases in 4 011 renal cases investigated at his clinic. Hepler (1930) collected 249 cases from the literature and 7 of his own of which 216 were large serous cysts and 40 were haemorrhagic. They are very rare in children and more frequently occur in middle life but have occasionally been found in the foetus and at all ages from adult life to old age. Forty five years is the average in Hepler's series. They are equally common in either sex and in either kidney.

**Pathology**—The cysts are more frequent in the lower pole of the kidney but also arise in the middle or in the upper pole. In Fish's series of thirty two clinical cases the smallest cyst contained 350 c.c. and the largest 10 litres. The condition is benign. Usually the greater part of the cyst protrudes from the surface of the kidney but a portion of it is in contact with a hollow bed formed in the cortex and to this it is closely adherent. The surface is smooth and translucent and it can be seen that there is fluid within which fills the cyst to its capacity. This fluid is clear and amber coloured with a specific gravity of about 1005. It contains albumen a few epithelial cells some chlorides a small amount of urea and occasionally minute traces of blood. It is sterile. The cyst wall is thin and composed of fibrous tissue lined in whole or in part by cuboidal cells. Occasionally atrophied glomeruli and tubules are to be found in it. Sometimes the wall is partially impregnated with a deposit of calcium salts. Only very rarely can any communication between the cyst and the excretory system of the kidney be demonstrated.

**Ætiology**—Though such a cyst is solitary and the rest of the kidney appears normal not infrequently when the organ is laid open small cysts of the type seen in chronic nephritis are found and these are sometimes also present on the surface. The origin of solitary cysts is uncertain. It is considered probable that the cyst results from the blockage of a group of tubules and that coincident with this there occurs an anæmic degeneration of that portion of the kidney and this leads to fibrosis and the consequent obliteration of all effluent channels. It would therefore seem that their origin is related to a local degeneration in the kidney resembling the changes which are generalized in chronic interstitial nephritis. Hepler has produced typical solitary cysts experimentally in animals. Watkins (1939) has produced evidence that a solitary cyst may originate from a calyx the outlet of which has become obstructed thus leading to cystic dilatation and the name hydrocalyx is suggested for this condition (Fig. 32).

**Symptoms**—Solitary cysts when they are small and sometimes even when they are large do not necessarily give rise to symptoms. In other instances discomfort such as may be due to any intra abdominal tumour arises. Pain on the affected side is the most common symptom but it is not necessarily situated in the posterior renal angle more often it is merely an uncomfortable dragging sensation. As the cyst increases epigastric pain and perhaps vomiting sometimes occur from pressure upon the duodenum or stomach. With large cysts of the upper pole pain in the chest and shoulders and a chronic cough have been recorded (Greenberg and Brodny 1934). The development of symptoms may be abrupt for occasionally these cysts grow with great rapidity. Urinary symptoms are uncommon but painless hæmaturia sometimes occurs. Rupture into the pelvis of the kidney has given rise to severe renal symptoms. Leakage into the perirenal tissues has also been recorded (Block 1932).

**Diagnosis**—A certain diagnosis of a renal cyst is not easily made apart from its identification at operation. Occasionally the patient notices the swelling and a large abdominal cyst of uncertain origin is then recognized but when the cyst is of moderate size examination usually reveals only an enlargement of a kidney which is painless smooth and moves on respiration. A cyst of the lower pole is more easily appreciated as a localized enlargement of the kidney but cannot necessarily be differentiated by abdominal examination from other tumours of the kidney. Examination of the urine is not helpful unless an attack of hæmaturia draws attention to the urinary tract and thereby leads to a full investigation. Renal function tests are normal.

**RADIOLOGY** in these cases often demonstrates a renal abnormality but rarely decides its nature. The kidney may be seen to be enlarged or it may be pushed downwards or downwards and forwards displacing the colon. If the wall of the cyst has undergone the rare change of calcification this will be obvious and even without this in a few instances the shadow of the outline of the cyst can be distinguished from the relatively more dense renal shadow. Ascending pyelography or excretion urography may give normal appearances but more often the calyces close to the cysts are pushed aside and perhaps compressed or even obliterated. The renal pelvis itself may be normal or somewhat dilated or distorted by contact with the cyst and if this is of considerable size marked displacement of both the pelvis and ureter may occur. However it is not usually practicable by radiology to differentiate a cyst from a solid renal tumour when abdominal examination has already failed to do so though Herbst and Vynalek (1931) record six successes. In cases in which there is a strong probability that an enlargement of the kidney is due to a cyst exploration with an aspirating needle through the loin has been used.



Fish in one case withdrew 1200 cc of fluid and replaced this with air. Antero-posterior and lateral radiograms combined with an ascending pyelogram then demonstrated the exact nature of the disease.

**Treatment**—If the kidney has been destroyed by the enlargement of the cyst or if renal infection is present then *nephrectomy* is the operation of choice. In a good many cases however the cyst can be excised. Often it is not possible to perform a clean enucleation from the kidney as there is no line of cleavage the cyst wall next to the kidney being intimately blended with the latter. In such instances the cyst may be emptied and cut away and that part of the wall which remains attached to the kidney then destroyed by diathermy. It is better however to excise it with a scalpel or a diathermy knife. The gap left in the kidney is entirely or partly closed by sutures and this is made easier if strips of muscle are laid over the outer surface of the kidney to prevent the sutures cutting through its substance. The kidney bed should be drained. There is always a risk of renal fistula if the excision has been extensive. In a case of an enormous tumour of the kidney probably a solitary cyst from which more than 25 pints of fluid were withdrawn Rock Carling (1914) after as much as possible of the cyst had been excised treated the remainder by marsupialization a renal fistula recurred at intervals. Fish in two cases which he considered unsuitable for operation injected 50 per cent dextrose solution into the cyst after the bulk of the contained serous fluid had been aspirated and this had the effect of sclerosing the wall of the cyst. Aspiration was repeated after a few days. Exploration with a needle in one case six months later in another case three years later found no fluid. The patients were free of pain and considered to be cured.

### POLYCYSTIC DISEASE OF THE KIDNEYS

#### (CONGENITAL CYSTIC KIDNEYS POLYCYSTONIA)

Polycystic disease of the kidneys is an hereditary congenital condition sometimes attaining to an advanced state in the foetus but often compatible with life up to middle age. The recognition of the disease is never easy in its earlier stages. Death is usually due to uremia. Surgical treatment should be reserved for a small group of cases and should be employed with much caution.

**Pathology**—The solid tissue of the kidney is destroyed and replaced by masses of cysts which do not communicate with the collecting system of the kidney. These vary from very minute proportions to the size of a grape the whole of the cortex and medulla are affected so that the kidney has a sponge-like appearance. The renal pelvis and calyces remain though they become distorted. The pelvis is often compressed but it is sometimes dilated. The calyces are narrowed and greatly elongated. Though the normal renal conformation is more or less preserved the surface of the organ is made irregular by the cysts which protrude from it. Such kidneys are sometimes of almost normal size but are more often enlarged and measure eight inches or very much more in length and may weigh many pounds. Often one kidney is much larger than the other. Sometimes though rarely only one kidney is affected. Naumann (cited by Dunger 1904) found 16 cases of unilateral polycystic disease in 10 000 autopsies. In the earlier stages some portion of solid renal tissue is still visible to the naked eye between the cysts but as these develop the kidney substance becomes more and more compressed until so little of it remains that the organ appears to be composed entirely of cysts. The microscope however shows

that glomeruli and tubules remain in the fibrous tissue septa, though they are compressed or distended and often atrophied. The cysts are lined by simple cubical or flattened epithelium, which occasionally proliferates into the cysts as minute papillæ. In some cysts the epithelium is destroyed and the wall is composed of fibrous tissue. The cysts contain a pale fluid in which small amounts of albumen, of urea and urinary salts and occasionally of cholesterol, are present. When hæmorrhage has occurred such kidneys are sometimes faintly red from the presence of recent blood in the cysts, but more often their



FIG 49

Right instrumental pyelogram in case of bilateral polycystic disease (See Fig 50) (Mr Cyril Nitch's case)



FIG 50

Left instrumental pyelogram in a case of bilateral polycystic disease (Mr Cyril Nitch's case)

contents have a brownish tinge and the fluid is viscous. Calculi are occasionally found in the cysts. Walters and Braasch (1934) found them in 5 out of 85 cases that required operation. They are usually composed of phosphates. Polycystic renal disease is sometimes accompanied by the presence of cysts in the liver, the ducts being dilated. If these are found at laparotomy the kidneys should be examined before any extensive procedure is undertaken. Cysts are occasionally also present in the pancreas and other organs. Hypertension with hypertrophy of the heart often accompanies polycystic disease. In 74 cases recorded by Schacht (1931) hypertension was present in 75 per cent. Cooke (1936) records a case of polycystic renal disease associated with infantilism. Ten days before death the blood urea was 700 mg, 100 cc of urine. Other congenital anomalies are occasionally associated, such as cleft palate or club foot. Inflammation of mild degree is common in polycystic renal disease, small amounts of pus being present in the urine. It is less often, however, that organisms are found or that the urine is obviously septic. Sometimes such infection can be proved to be unilateral, and it has been described as being localized in one group of cysts. Perinephric abscess has occurred as a complication of the infection of a cystic kidney. Death is

usually due to uræmia Sieber (1905) found that 50 cases had died of uræmia out of 98 in which post mortem examinations had been made Kuster (1907) gives a table showing the ages at which death from all causes occurred in 239 cases —

Stillborn or dying shortly after birth	59
Died in first year	10
1 to 5 years	6
5 10	1
10 20	4
20 30	22
30 40	24
40 50	53
50 60	41
60 70	10
70 80	6
80 90	3

The incidence in the newborn and the fact that subsequently very few cases occur until after twenty years is well seen

**Ætiology**—This is uncertain Virchow believed that inflammation and interstitial overgrowth of fibrous tissue compressed the tubules and that they subsequently became dilated Other theories are that there is a failure of union between some of the tubules and their glomeruli or one or other of these units is present in excess and subsequently becomes dilated Another explanation is that portions of the primitive mesonephros persist and mingle with the metanephric structures

**Heredity**—The condition is hereditary and either sex may transmit the abnormality Cairns (1925) studied a family in which eight members and perhaps more were affected in three generations and Tuller (1929) followed the disease through four generations It is obvious that in many instances on account of the late onset of signs and symptoms the patient will have married before being made aware of this risk to the offspring

**Sex**—It is often stated that the disease is equally common to either sex Willan (1928) however in a series of 22 cases found the condition slightly more common in the female 13 against 9 males

**Symptoms and signs**—The patient may live and die without showing any evidence of the disease This is evidenced from post mortem findings also Walters and Braasch in describing 85 cases operated upon include 11 in which the condition was only recognized when laparotomy was performed for some other condition Diagnosis would have involved complete investigations of the urinary tract to which there were no leading symptoms It is usually not until the patient reaches an age of between 30 and 60 years that the disease becomes apparent and occasionally old age is attained without symptoms Sieber in a series of 244 cases found that only 18 survived to the age of 60

Oppenheimer (1934) gives the ages of 59 cases in which a diagnosis was made —

Years	Patients
1 to 9	
10 19	2
20 29	14
30 39	17
40 49	18
50 59	8
60 69	

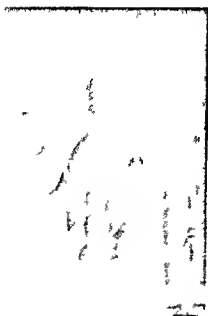


FIG 51

Instrumental pyelogram of right kidney in bilateral polycystic disease man aged 41 (Mr W I Irwin's case)

none or it may only occur at a later stage and terminal anuria is common and when symptoms are present a full investigation of the patient will nowadays establish a certain diagnosis. Uræmia is increased if infection supervenes. It is usually of gradual onset but in a case described by Doolin (1941) it was precipitated in a fatal form by a relatively slight accident. The patient was thrown from a van and injured his shoulder. He was not shocked or unconscious until the next day when he became comatose and he died of uræmia eighty hours after the accident. At the post mortem both kidneys were in an advanced state of polycystic disease. The case illustrates well that general good health is not necessarily affected by this condition for he had served as a policeman, been accepted for life insurance and never lost a single day's work through illness. Next to these symptoms the presence of an ABDOMINAL TUMOUR is the sign by which a diagnosis is most often established and although both kidneys are usually affected frequently only a unilateral tumour is found clinically. According to Thomson Walker (1936) this is so in 76 per cent of cases.

However he also found records of 29 cases in which the disease was present between the ages of 2 and 20 years. Clearly therefore the condition in a stage sufficiently advanced to be recognized is not unknown in youth though this is rare. By the time the condition is sufficiently advanced for a diagnosis to be made the expectation of life is short if uræmia exists in other patients it may be five or ten years. The commonest initial symptom is PAIN in the loin. Often this is a dull ache. Sometimes it occurs as a renal colic. In Willan's series of 22 cases 5 had renal colic 7 had less severe pain. The pain is considered to be due either to the drag of the heavy kidney upon its pedicle or to tension within the cysts. Haemorrhage into the cysts may make this pain severe and the passage of clots though this is uncommon may be another cause of colic. Pain is sometimes experienced throughout the disease but often there is RENAL FAILURE leading to uræmia.



FIG 52

Instrumental pyelogram of the left side in a case of bilateral polycystic disease a male aged 37 (Dr D W Mackenzie's case)

A kidney which is enlarged by polycystic disease is felt as a painless mobile renal tumour and one which may lie unduly low in the abdomen especially if it is on the right side. Not infrequently the irregularities produced by the surface cysts can be recognized. The URINE is usually abundant though there are sometimes periods in which the volume is greatly diminished. The specific gravity is about 1010 or less and a trace of albumen may be present urea and salts are diminished and casts are occasionally found. Small amounts of pus are often present and the urine may become infected but more than a slight rise of temperature is uncommon unless the infection is severe. HÆMATURIA occurs in about one quarter of the cases. It is usually intermittent lasting



FIG. 53

Sectioned kidney in a case of bilateral polycystic disease. The patient was a woman aged 34 who died from carcinoma of the parotid. (Dr Frank Patch's case)

only a few days and perhaps does not recur until after a long interval. It may be sufficiently abundant to lead to the retention of urine from clot in the bladder and sometimes it is very profuse and a cause of much anxiety. BLADDER SYMPTOMS are only present if infection supervenes or when clots of blood are present.

**Diagnosis**—Several aspects of this have already been mentioned but the most accurate method is pyelography. Excretion UROGRAPHY usually gives the information desired but if the shadows are too feeble ascending pyelography may be necessary. This is by no means without danger and only one kidney should be investigated at a time lest fatal uræmia be induced. The radiograms are characteristic: the pelvis is usually of normal size compressed or rather swollen. The major calyces are elongated and narrowed and they straggle through the kidney to the minor calyces which may be clubbed

but are often not dilated. The course of the ureter may be displaced inwards in its upper part by the protruding lower pole of the kidney. Sometimes, however, the pyelographic appearances resemble those produced by a neoplasm. RENAL FUNCTION TESTS should be carefully studied. The blood urea may be normal but even a slight elevation in this figure is important, and if it is above 50 mg per 100 c.c. of blood there may be only just enough renal tissue in function to avoid uræmia. Urea concentration tests even in an early stage of the disease rarely show more than 2 or 2.5 per cent and often only 1.5 per cent. The excretion of indigo-carmin observed through the cystoscope is another sensitive test in these cases. Delay in the appearance of the dye and persistent faintness of colour in the effluxes will be observed before there are any obvious signs of renal failure. Phenol sulphone phthalein and urea clearance tests are also useful.

**Treatment**—In the majority of cases there is nothing to be done. Surgical measures have, however, been employed with success to treat pain, bleeding or infection. PAIN due to tension within the cyst can sometimes be relieved by Rovsing's operation. The kidney is exposed, usually through the loin, and many of the cysts, the largest ones in particular, are punctured and then allowed to drain into the perinephric tissue. Some of them may be excised. Since the cysts extend throughout the kidney, such treatment is inevitably incomplete. Moreover, the surgeon must not attempt too much for there are obvious risks of introducing infection into a degenerate organ or spreading it if it already exists and also of precipitating uræmia. Nephrectomy has been performed for severe infection combined with cystic degeneration when the opposite kidney is considered to be normal, but clearly there must always be uncertainty that disease is not already present in an early form. That surgery has occasionally a place in the treatment of this disease is shown from the following figures. Walters and Braasch describe the results in 85 cases submitted to surgical treatment. The Rovsing operation was done for pain and nephrectomy for advanced infection including 5 cases with calculi and 3 with malignant disease.

TABLE I  
ROVING OPERATION AND REMOVAL OF CYSTS

	Patients	Deaths in Hospital
Rovsing operation	24	Per Cent
Removal or enucleation of cysts	5	16.6
TOTAL	29	13.8
Survived operation—25 cases		
Patients now living	13	
Less than 3 years	2	
8 to 21 years	11	
Patients now dead	7	
Lived more than 10 years	1	
Lived 5 to 10 years	3	
Lived 3 to 5 years	2	
Lived less than 3 years	1	
Not traced	5	

TABLE II  
RESULTS FOLLOWING PRIMARY NEPHRECTOMY FOR POLYCYSTIC KIDNEY (TWENTY-EIGHT CASES)

	Patients	Per Cent
Now living	18	64.2
After 19 years	1	
13 to 19 years	4	
7 to 13 years	3	
4 to 7 years	3	
8 months to 4 years	7	
Dead	5	17.8
Lived 9 to 13 years	2	
Died within 3 years	2	
Died in hospital	1	
Not traced	5	17.8
Nephrectomy was performed secondarily to Rovsing operation in three additional cases Total number of nephrectomies 1 patient died in hospital, mortality	31	3.2

Meltzer (1929) submitted a questionnaire to members of the American Urological Society to which answers were received concerning the results of operation in 111 cases with unilateral surgical symptoms. Nephrectomy was performed in 59 cases, Rovsing's operation in 31 and lesser operations in the remainder. The results were as follows —

4 patients alive for 48 hours	
24 " " " 3 days to 6 months	
20 " " " 6 months to 2 years	
44 " " " 2 years to 8 years	
3 " " " 9 years	
1 " " " 11 "	
1 " " " 12 "	
1 " " " 13 "	
2 " " " 14 "	
1 " " " 15 "	
10 patients not followed up	

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## CHAPTER XI

### NEW GROWTHS OF THE KIDNEY AND URETER

#### PARANEPHRIC GROWTHS SUPRARENAL GROWTHS

**N**EOPLASMS of the kidney may arise from the renal parenchyma or from the epithelial lining of the renal pelvis. The majority of tumours arising in the renal tissues are malignant in character but classification of them is difficult owing to the fact that pathologists at present agree upon neither their histogenesis nor their histological characters. It is useful however to classify them as innocent or malignant tumours.

#### RENAL PARENCHYMA—

*Innocent tumours*—adenoma

fibroma

angioma

leiomyoma

*Malignant tumours*—hypernephroma

alveolar carcinoma

embryonal adenocarcinoma

#### RENAL PELVIS—

*Innocent tumours*—papilloma

*Malignant tumours*—papillary carcinoma

squamous celled carcinoma

#### TUMOURS OF THE RENAL PARENCHYMA

**Innocent tumours**—These are very rare and seldom give rise to symptoms. **ADENOMATA** are occasionally found as small greyish nodules in the renal cortex usually in kidneys affected by interstitial nephritis. Sometimes these adenomata contain small cystic cavities lined by cubical epithelium in which papillary processes may be formed. These tumours exceptionally become large enough to be palpable in the loin. From a patient aged 20 Gordon Taylor removed one such tumour weighing 22 lb. which he described as a fibro adenoma. Cases of large adenoma have been described by Kretschmer and Doehring by Creevy and by Kessler some of them causing hæmaturia. There has been much speculation among pathologists as to whether an adenoma may become malignant and it has been said that the larger tumours may be carcinomata although no metastases can be found.

**ANGIOMATA** of the cavernous type have been recorded giving rise to such profuse hæmaturia in young adults as to demand nephrectomy in order to save life.

**Malignant tumours**—With regard to malignant renal growths it is only rarely that the kidney is the seat of a metastasis from a growth elsewhere in the body. As to primary malignant tumours of the kidney these are much commoner than innocent tumours. The commonest of these malignant growths are classified as hypernephromata but there still remains considerable doubt as to the origin of these tumours. They were originally described



by Grawitz in 1883 as encapsulated tumours of the cortical portion of the kidney traversed by septa and having a cellular arrangement resembling adrenal tissue and arising from islets of adrenal tissue remaining in the renal cortex in the process of development from the Wolffian ridge Lubarsch and Birch Hirschfeld supported this view but it was disputed by Sudeck and by Stoerk who showed that these tumours had a papillary structure which is absent in adrenal growths Wright supported the papillary formation of renal tumours and looked upon this formation as a constant feature of growths arising in the renal cortex

Doubt has been expressed as to whether aberrant islets of suprarenal tissue are actually found under the renal capsule but Shaw Dunn and Ewing definitely state that they do exist Robertson Ogilvie states his opinion that hypernephromata are of renal origin and are not derived from adrenal rests whilst MacCallum is inclined to favour the Grawitz view of origin from adrenal rests Shaw Dunn (1911) suggests that hypernephromata may arise from cystic adenomata in the renal cortex

Nicholson (1922) in an important paper on the genesis of hypernephromata states that they arise in the renal epithelium and that no hypernephroma has been recorded in which an origin in suprarenal tissue as assumed by Grawitz has been proved Ewing (1940) states that these tumours arise in the renal epithelium and divides them into papillary and alveolar carcinomata reserving the term hypernephroma for the rare tumours arising from adrenal rests Haukeley and Newcomb however have shown that the papillary and alveolar types described by Ewing are often both present in the same tumour

Newcomb in 1936 showed that kidneys frequently contain small adenomata 1,172 consecutive autopsies yielding 147 of these tumours Their structure is mostly that of papillary cystadenomata but there are also large clear cells containing glycogen closely resembling the vacuolated cells of the Grawitz tumour His opinion is that malignant renal tumours arise from these adenomata that they are of renal origin and that no proof exists that they are of adrenal origin

Inch (1940) adduces the following reasons against the adrenal origin of hypernephromata —

- 1 The clear appearance of the cells of the adrenal cortex is due to the dissolving out of lipoids in the course of preparation that of hypernephroma is due to the dissolving out of glycogen
- 2 Adrenal rests very seldom produce hypernephromata in other organs
- 3 Adrenal tumours give rise to marked endocrine disturbance such as hirsutism hypernephromata do not
- 4 Corticin is easily abstracted from adrenal tumours there is none in hypernephromata
- 5 It would be strange for the most common tumour of the kidney to arise from something which is not normally present

American pathologists incline to the view that there are two forms of hypernephroma both arising from papillary cystadenomata One form remains as an encapsulated tumour for months or years and then may take on malignant characteristics while the other form rapidly invades the kidney and adjacent structures They point out the great similarity of the histological features of the two forms and the great difficulty in differentiating them unless they have given rise to metastases Bell states that in 20 000 autopsies 149 tumours were found Of these 65 measured less than 5 cm in diameter and only 5 showed metastases whereas in 84 which were larger than 5 cm in

diameter no fewer than 66 showed metastases although the histology of the two groups was similar Kozoll and Kirshbaum (1940) in a study of 77 renal tumours think that the benign tumours become malignant and would classify them as benign only when no metastases are found Creevy (1931) quotes a case of an encapsuled tumour of 3 cm in diameter which caused hæmaturia but was malignant

HYPERNEPHROMATA may occur in any part of the kidney At first rounded in shape they gradually compress the renal tissue as they increase in size,

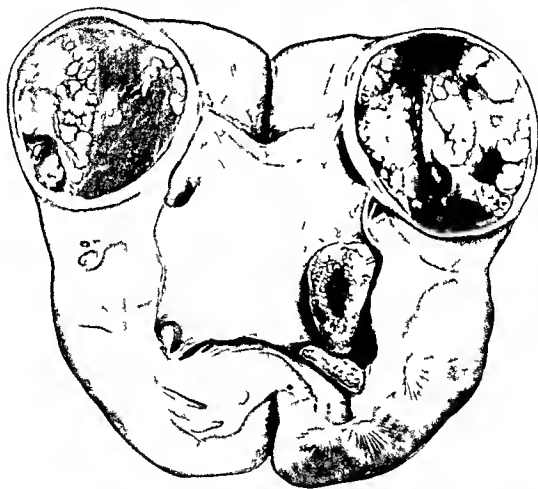


FIG. 54

Nephrectomy specimen showing hypernephroma at upper pole and two calculi in pelvis of right kidney in a man of 51 (Sir Gordon Gordon Taylor's case)

so that in some cases they appear to be encapsuled whereas in others the kidney is directly invaded by the growth without any clear line of demarcation. The tumour may form a localized rounded bulge on the surface of the kidney and by gradual extension may infiltrate the calyces or renal pelvis giving rise to hæmaturia. The growth tends to spread along the veins eventually reaching the renal vein from which emboli may pass to give rise to metastases most frequently in the lungs long bones or skull. The lymphatic glands about the aorta in the mediastinum or even above the clavicle may become involved while the growth may penetrate the renal capsule to the perinephric fat and become fixed to the liver diaphragm or colon.

On section the growth presents a fairly characteristic macroscopic appearance (Fig 54). It is often surrounded by an apparent capsule of condensed renal tissue from which fibrous septa of a greyish colour pass into the tumour mass. The surface shows yellow areas of hæmorrhage and necrosis. Sometimes semi-transparent areas of mucoid degeneration are present. In the more rapidly growing tumours there is no apparent capsule; the tumour cells directly infiltrating the surrounding renal tissue.

On microscopic section the tumour cells appear as large clear polyhedral or cubical cells with small deeply staining nuclei. The cytoplasm is vacuolated from the presence of glycogen. The cellular arrangement varies considerably; the cells being sometimes grouped in solid trabeculae or in alveoli and sometimes in acinar or papilliferous formation. These various types may be found in different parts of the same tumour.

Whilst so much uncertainty exists as to the true origin of these growths it is perhaps advisable to include them under the generic term of hypernephroma and look upon them as malignant. It must be admitted that from a clinical aspect they differ widely in their virulence and metastatic spread; some remaining localized to the kidney and semi-encapsuled for months or years whilst others rapidly infiltrate the renal tissue and give rise to early metastases.

**ALVEOLAR CARCINOMA**—This is a relatively rare tumour occurring as a hard solid white mass infiltrating the kidney and not showing the areas of hæmorrhage or necrosis so common in a hypernephroma. Histologically the cells do not show the large clear cytoplasm loaded with granules of glycogen but form a solid mass with little cellular differentiation.

**EMBRYONIC ADENOCARCINOMA (WILMS'S TUMOUR)** is a special form of renal tumour which is seen most frequently in children under the age of 5 years though very exceptionally in adults. It forms a rapidly growing highly malignant tumour of which the first sign noticed by the child's parent or nurse is an increase in the size of the abdomen together with anæmia, lassitude and loss of weight.

There has been much discussion as to the pathogenesis of these tumours the true nature of which still remains in doubt. They were at first thought to arise in remnants of the Wolffian body but were stated by Wilms to originate from primitive undifferentiated mesodermal tissue from which the various elements of the mixed tumour might arise by metaplasia. Ewing considers that they arise from the renal blastema and attributes a prominent part in their pathology to metaplasia.

Macroscopically the tumours show a smooth surface apparently enclosed in a capsule of condensed renal tissue without definite infiltration. The cut surface is white or pink in colour and mostly uniform but there may be areas of necrosis or staining from hæmorrhage. Microscopically the section shows loose connective tissue containing epithelial cells arranged in tubules or acini with oval or spindle cells like those of fibrosarcoma. There may also be unstriped or striped muscle elements (Fig 55) together with islets of fat or cartilage.

**Symptoms and signs**—There is progressive enlargement of the abdomen from an increasing tumour of one side which may reach such proportions as to fill the whole abdomen. At first the tumour is mobile on respiration but it is seldom that a case is seen in an early stage. The surface is smooth or only slightly bossed and firm in consistence. Urinary symptoms are very slight and in contradistinction to other malignant tumours of the kidney hæmaturia is exceptional. There may be aching pain, pyrexia with progressive anaemia.

loss of weight and dyspnoea from pressure on the diaphragm. Metastases may be found in the peri aortic lymph glands or in the lungs.

*Diagnosis*—An increasing tumour in the loin in a child should arouse suspicion of Wilms's adenocarcinoma of the kidney, though a similar mass might be formed by a retroperitoneal sarcoma. The diagnosis between these conditions is based on pyelographic differences. With a renal tumour there are marked changes and deformity in the outline of the renal pelvis and calyces, whereas in the case of a retroperitoneal tumour, the kidney may be displaced without much deformity of the renal pelvis.

*Treatment*—The removal of a large Wilms's tumour in a young child is always a severe operation and the great majority of patients die within a year of the operation from recurrence of the disease, either locally, in the abdomen or in the thorax. Kretschmer (1938) tabulated twenty-four cases, only two of the patients being alive after three and a half years, and another after two and a half years. Priestley and Schulte (1942), in a table produced from the Mayo Clinic, report six patients alive and well out of thirty-nine upon whom nephrectomy was performed five or more years previously.

It has been recently shown that Wilms's tumour is actively radio sensitive, and in many cases a full course of deep X-ray therapy has reduced the size of the tumour very considerably, and has rendered nephrectomy a much simpler operation, in fact, the reduction in size of the mass by X-rays has been urged as a diagnostic test for Wilms's tumour. However, this test is not a certain one, for some tumours have not reacted under treatment. Nor can X-ray therapy alone be regarded as adequate treatment for a Wilms's tumour, since it is usual to find viable tumour tissue still present when nephrectomy has been carried out after irradiation. It seems probable that, whereas some of the mixed tissue cells in the tumour may be very radio sensitive, other parts may be radio resistant and progress in spite of treatment. It may be argued that, during the lapse of the four to six weeks necessary for an efficient course of X-ray therapy, distant metastases may occur, and that the treatment may cause malaise, but when diminution in size is obtained, there is no doubt that the subsequent nephrectomy is easier and safer. From figures recently produced it seems that the best results in these cases are obtained by the threefold course of pre operative irradiation, nephrectomy when definite decrease in size has been achieved and prolonged post operative X-ray therapy.

#### MODE OF SPREAD

Hypernephromata are prone to spread along the veins to the main renal vein from which small emboli of cells may reach the inferior vena cava and thence the lungs. Direct infiltration of the growth may occur through the capsule to the perinephric tissues, peritoneum, intestine, liver or diaphragm whilst the lymphatic glands around the renal vessels and aorta may be involved. Metastases from renal growths are common in the long bones and in those of the skull. Metastases occasionally occur before there has been any symptom referable to the kidney, thus pathological fracture of a bone, or enlargement of the supraclavicular or axillary glands may be due to metastases from a quite small hypernephroma.

#### SYMPTOMS AND SIGNS

The cardinal symptoms of a renal growth are hæmaturia, tumour and pain.

**Hæmaturia** is the most common symptom and in the majority of cases first attracts the patient's attention. It is present in 90 per cent of all cases,

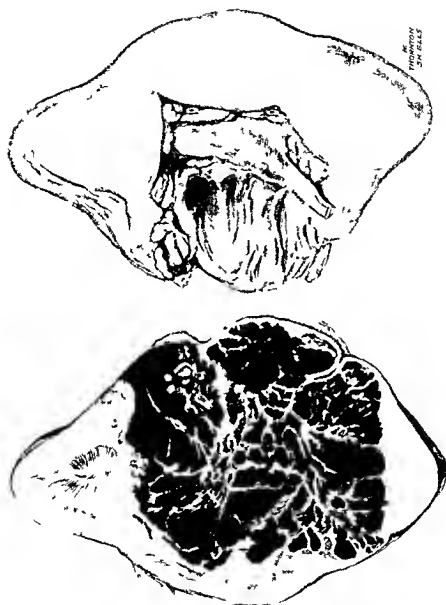


FIG. 53

Sectioned and reverse view of a nephrectomy specimen showing a karyosarcoma from a man aged 40 (M. W. H. 1906 rj H 10 2 2 2 2)

is usually fairly profuse and sudden in its onset and is often related to exercise or strain. It may last a few days and return after a varying interval, it being usually the recurrence of bleeding that persuades the patient to seek advice. In one exceptional case under my care the patient had had recurrent attacks of fairly profuse hæmaturia from a renal growth for several years before nephrectomy, which was performed at the age of 63, and which the patient survived for thirteen years. Hæmaturia occurs in all forms of renal growth, but it is exceptional in the embryonic adenocarcinoma (Wilms's tumour) of children.

The severity of the bleeding bears no relation to the size of the growth, for quite small tumours which have involved the renal calyces or pelvis may cause profuse hæmorrhage, whereas comparatively large tumours may be accompanied by only slight bleeding. The hæmaturia may be painless but, if there is much bleeding, clots may be found in the renal pelvis or in the ureter, giving rise to typical renal or ureteric colic in their passage to the bladder. The clots may be elongated or worm-like suggesting their formation in the ureter. The bleeding may be so profuse that the bladder becomes filled with clot, dysuria or retention of urine resulting.

Pain is present in many cases. It may take the form of ureteric colic, due to the passage of blood clot along the ureter, or be caused by clot in the bladder, with increased desire to micturate. Pain in the loin may be due to increased tension in the tumour from the occurrence of hæmorrhage into its substance, or to extension of the growth into the perinephric tissues. In advanced cases pain may be caused by pressure on, or direct invasion of, a nerve root by a vertebral metastasis.

A tumour may be palpable and in children may be the first and only symptom of a renal growth. There is a rounded mass that can be grasped bimanually and felt to descend on deep inspiration. The colon is usually in front of the tumour, can sometimes be rolled on its surface, and gives a resonant note on percussion. A tumour of the upper pole of the kidney may not be palpable, but in such a case the lower pole of the kidney can sometimes be felt to descend to more than the usual extent on deep inspiration. In two cases under the writer's care a tumour in the upper pole of the right kidney pushed the liver forwards and downwards about a transverse axis, so that the anterior edge of the liver descended well below the costal margin and prevented palpation of the enlarged kidney. Impaired mobility of a renal tumour on forced inspiration suggesting as it does the occurrence of perinephric infiltration is a bad prognostic sign.

**The urine**—Apart from blood, albumen and casts may be present and are derived from the area of nephritis surrounding the growth. Pus is usually absent except in those rare cases in which a calculus also is present.

Varicocele has been stated to be frequently present, but this is not so. A varicocele in a man of over 50 years is a suspicious feature, and may be due to the pressure of a growth or enlarged gland on the spermatic vein. Such a varicocele does not disappear on recumbency.

### DIAGNOSIS

The combination of hæmaturia, localized lumbar pain, and tumour palpable in the renal area should form fairly conclusive evidence of a new growth in the kidney. It is not uncommon, however, for a patient to present himself when hæmaturia is the only feature. Intermittent painless hæmaturia may be due to a vesical or to a renal growth, and it cannot be too strongly urged

that every case of hematuria should be completely investigated to discover the source of the bleeding. Cystoscopy should be undertaken even in the presence of hematuria. Should the bleeding be renal in origin vesical irrigation will soon produce a clear medium when blood will be seen emitted from a ureteric orifice the source of the bleeding being thus immediately localized. On the other hand should the bleeding arise from a vesical growth or from an enlarged prostate careful irrigation with a solution of silver nitrate (1 in 4000) will usually produce a medium clear enough for diagnostic purposes. In a few cases in which hematuria has been accompanied by lumbar pain cystoscopy has proved the presence of a vesical growth obstructing one ureteric orifice and causing pain from renal distension.

In those cases in which hematuria is not present but in which a renal growth is suspected cystoscopy may give no information as the bladder wall is normal and clear urine may be seen coming from each ureteric orifice. In such a case an intravenous injection of 10 or 12 c.c. of a 0.4 per cent solution of indigo carmine is given and the time elapsing before colouration of the urine from each ureteric orifice noted. In a normally functioning kidney this colour should be seen within seven minutes rapidly deepening in intensity to a dark blue. Delay in the time of appearance or failure to deepen rapidly in colour is evidence of renal dysfunction. Segregation of the urine from each kidney by ureteric catheterization may show a diminished urea content on the affected side. These tests should be carried out not only to confirm suspicion pointing to a particular kidney but also to prove the functional capacity of the opposite kidney. No reliance can be placed on the presence of blood in the urine collected by a ureteric catheter as bleeding may be due to instrumental trauma.

The palpation of a renal tumour may not be easy especially in a stout or muscular patient. With a tumour in the upper renal pole the kidney may be palpable on bimanual examination during deep inspiration the lower pole occupying a lower level than usual owing to its being pushed down by the growth. As already stated a growth of the upper pole of the right kidney may displace the liver downwards and forwards thus preventing palpation of the enlarged kidney. A tumour of the lower pole may be felt as a rounded swelling smooth or slightly bossed on the surface and moving with the kidney on deep inspiration. As the growth extends it tends to infiltrate the perinephric tissues and adhere to adjacent structures becoming consequently less movable. This diminished mobility should be looked upon as a bad prognostic sign.

Renal tumours may attain considerable size especially in the case of the *embryonic carcinomata of children* and differential diagnosis will be necessary between those on the left side and splenic or gastric tumours and between those on either side and growths in the liver colon or retroperitoneal tissues. Palpation of both sides should be carried out to exclude the possibility of polycystic disease in which both kidneys are usually enlarged though one may be larger than the other.

Radiography may play an important part in the diagnosis of a renal tumour. A plain film may show enlargement of the kidney whose outline presents a localized rounded irregularity. In a few cases one may see areas of increased density due to calcification within the tumour (Fig. 56).

More information may be obtained by pyelography. An intravenous injection of uroselectan or pyelectan may show some irregularity in the outline of the renal pelvis or calyces but it is frequently necessary to confirm these findings by ascending pyelography. Owing to the considerable variations

that occur depending on the position and size of the tumour there is no pyelographic pattern distinctive of a renal growth. In an early polar growth the calyces are at first elongated and narrowed and the cup like minor calyces obliterated. Occasionally there are localized dilatations of the calyces. With increasing size of the tumour the calyces may become obliterated (Fig 57) and pressure on the renal pelvis may cause flattening or concavity of its outline. Later on the deformity of the calyces and pelvis increases the latter often becoming considerably narrowed or obliterated (Fig 58).



FIG 56

Large left calcified hypernephroma  
(Mr A E Roche's case)

With a papillomatous tumour of the renal pelvis whether simple or carcinomatous a filling defect in the pyelogram may be present (Fig 59) together with dilatation of the pelvis and of some of the calyces. A similar filling defect is occasionally seen when a hypernephroma has fungated into the renal pelvis or when the pelvis is occupied by blood clot. In tumours of the lower pole of the kidney the upper part of the ureter may be pushed towards the middle line showing a concavity outwards.

The elongated spider like calyces of a polycystic kidney may resemble the deformed calyces of a renal tumour but with polycystic disease usually all the calyces are affected and the other kidney is similarly though unequally affected. Rarely a solitary cyst of the kidney may not only cause it to be palpable and enlarged and the calyces displaced but may also give rise to the same concavity in the pyelographic outline as that caused by a growth and thus lead to difficulty in diagnosis. In such a case hæmaturia is usually absent. A non opaque calculus in the renal pelvis may give rise to a filling defect and resemble a pelvic growth. In such a case hæmaturia would not be profuse.





FIG 38

Incretin pyelogram of left kidney the seat of an extensive hypernephroma in a male age 14 (Mr Winslow White's case)



FIG 39

Instrumental pyelogram of carcinoma of right kidney in a woman aged 83 (Dr F. Patel's case)



FIG 39

Instrumental pyelogram of left kidney the seat of a papillary carcinoma (Mr Winslow White's case)

In cases in which a tumour is present in the upper abdomen and in which other symptoms are indefinite difficulty may be found in making a diagnosis between a renal tumour and one of the spleen, colon, liver, or gall-bladder. In such a case a normal pyelographic outline indicates that the tumour is not renal in origin. In other cases pyelography may show that the kidney is displaced or rotated by some extrarenal tumour, such as a retroperitoneal sarcoma or a mass of secondary carcinomatous glands. In such a case the actual deformity of the pelvis and calyces is less than with a renal growth.

In every case in which a renal growth is suspected an X-ray examination of the thorax and skeleton should be made for metastatic deposits of growth before removal of the kidney is contemplated.

### TREATMENT

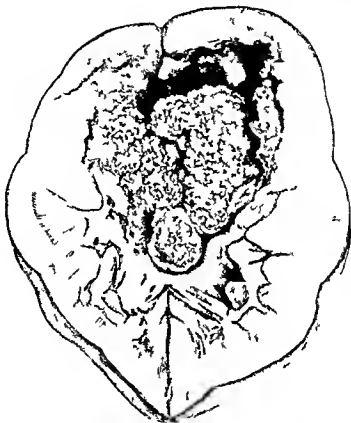
The occurrence of intermittent hæmaturia proved by cystoscopy to be proceeding from one ureteric orifice coupled with pyelographic deformity of the renal pelvis or calyces arouses such strong suspicion of the presence of a renal neoplasm that operation with a view to complete removal of the kidney, together with the perinephric fatty tissue and lymph glands about the renal vessels should be contemplated. In many cases a tumour is not palpable, especially in a stout muscular patient, or with a growth in the upper pole, but this should not contraindicate operation. Before operation is decided upon, a careful search should be made by X-ray examination for metastatic spread in the lungs or bones, and the functional activity of the other kidney estimated. Early diagnosis is of prime importance, but may be difficult, though unilateral hæmaturia should always give rise to a suspicion of renal growth. The actual pathology of the tumour is of secondary importance, as the treatment remains the same, but, where evidence exists that the growth arises in the renal pelvis and is of the papillomatous type, the whole length of the ureter should be removed with the kidney by combined lumbar and iliac incisions as described in the section on New Growths of the Ureter. The juxta-ureteric part of the bladder should also be resected, or else diathermy substituted.

The operation for removal of a renal tumour may be difficult, owing to profuse hæmorrhage from the dilated, thin, and easily torn veins covering these growths. It is therefore advisable to be able to control the vessels of the renal pedicle early in the operation. Although many growths can be removed by the lumbar approach in which additional room is obtainable by resection or upward dislocation of the twelfth rib many surgeons prefer a transperitoneal operation by which means the regional glands and liver can be explored for metastases, and the renal vessels ligatured before much separation has been effected, and thus much of the troublesome and dangerous hæmorrhage prevented. Early ligature of the renal vein may also prevent small pieces of tumour tissue being forced into the vein during the manipulations of removal. The renal vein should be defined to its junction with the inferior vena cava, and the ligature applied as close to the latter as possible, owing to the frequency with which a renal growth spreads into the lumen of the vein. On the right side particular care must be taken in the separation of the mass from the duodenum, as injury to the latter may result in a duodenal fistula.

It is often impossible to tell the actual nature of a renal tumour until it has been microscopied. It should be remembered however, that carcinomata, including both hypernephromata and the alveolar forms, are far more frequent than pelvic tumours, which comprise only 7 per cent of all renal growths.

papillomata should be regarded as possessing a large measure of potential malignancy

Another form of malignant growth arising in the renal pelvis is the squamous celled epithelioma. It has been stated to arise in leucoplasic patches in the pelvic mucosa remaining from old standing infections and has been found in association with renal calculi but it is uncertain whether the calculus precedes



FIG

Papillary carcinoma of left renal pelvis, neplrectomy specimen from a man aged 71 (Mr John E. Edwards)

the commencement of the epithelioma or is secondary to it. These tumours spread by direct infiltration of the surrounding tissues and involve the lymphatic glands about the renal vessels and aorta.

### NEW GROWTHS OF THE URETER

New growths of the ureter are distinctly rare. They may be present in association with papillary growths of the renal pelvis either as surface implantations or as the result of some common aetiological factor. This question has been discussed in dealing with Renal Tumours. Ureteric growths may however arise primarily in the ureter or else spread to it from some advanced growth in a neighbouring organ such as the bladder, prostate or uterine cervix. It is proposed to deal here only with primary neoplasms of the ureter.

Improved methods of urological investigation doubtless account for the large proportion of cases reported in recent years. Thus while Scott reporting



FIG 63

Villous papilloma seen in profile projecting from left ureteric orifice

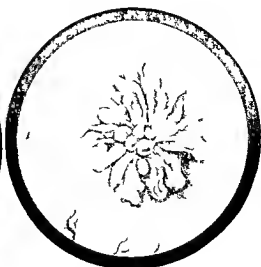


FIG 64

Lobulated view of same growth

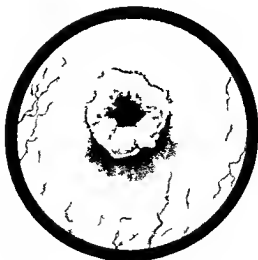


FIG 65

Appearance of site of growth (Figs 63 and 64) immediately after coagulation (Mr W. W. Nabury, W. case)

two cases in 1934 was able to collect only 59 others from the literature, by 1938 Rusche and Bacon were able to collect 96 cases of malignant disease, and 40 of benign papillomatous tumours of the ureter. In 1939 Foord and Ferrier reported 6 cases and collected 139 others, 4 more were added by Stang and Hertzog in 1941 and in 1942 cases were reported by Moore and by Riches.

Like epithelial growths of the urinary bladder, these tumours present some difficulty in classification. The majority are papillomatous in character (Figs 63 64 and 65) but a definite opinion as to malignancy can be given only after complete histological examination. As in the bladder, any papillomatous tumour may show a gradual transition from innocency to malignancy. Only when the covering transitional epithelium shows complete regularity of structure in all parts and when there is no infiltration of epithelial cells at the area of attachment, can an individual tumour be said to be innocent. All papillomatous tumours of the urinary tract should be looked upon as potentially malignant and, unless entirely eradicated, may undergo carcinomatous change.

Malignant tumours of the ureter may be of the papillary type or may occur as a solid, infiltrating squamous carcinoma. The proportion of each type varies in different series of cases. Thus, whereas Swift Joly (1933) states that, of 133 cases of ureteric growth, 101 were papillary, of the 145 cases collected by Foord and Ferrier only 75 were classified as papillary carcinomata. If, as is probable, some of the tumours classified as infiltrating were in reality the later stage of an original papillary growth, a high proportion of papillary growths in a given series of cases might be explained by the inclusion of a large number of relatively early cases. These growths may occur in any part of the ureter, but most commonly in the lowest third. They may be limited to one aspect of the ureter, but the whole lumen may become involved, and infiltration spread to the periureteric tissues, neighbouring organs or regional lymph glands.

Tumours of mesodermal origin, such as fibroma, myoma, neurofibroma and sarcoma have been reported, but are very rare and must be looked upon as surgical curiosities.

The presence of a tumour in the ureter gives rise to mechanical obstruction to the normal outflow of urine and in consequence the proximal portion of the canal becomes dilated whilst later the renal pelvis and calyces may show evidence of back pressure (Fig 66). The increased peristaltic action of the ureteric musculature leads to elongation of a pedunculated growth, a portion of which if the growth is situated low in the ureter, may be protruded through the ureteric orifice into the bladder, and be seen on cystoscopy, to be alternately expelled and retracted through the orifice during ureteric systole and diastole. In fact, in many cases the diagnosis has been reached by this observation. Occasionally a ureteric growth may be accompanied by a calculus. According to Lazarus this occurs in 15 per cent of cases, but it is doubtful whether the calculus should be looked upon as an aetiological factor, or as the result of stasis and infection above the growth. Metastases are not infrequent, Scott found them in 23 out of 62 cases, whilst in 8 there was direct spread to other organs.

#### SYMPTOMS AND SIGNS

The prominent features are hæmaturia, pain and renal enlargement. The hæmaturia is usually of the intermittent type, appearing suddenly without obvious cause, lasting a short time, and tending to occur more frequently

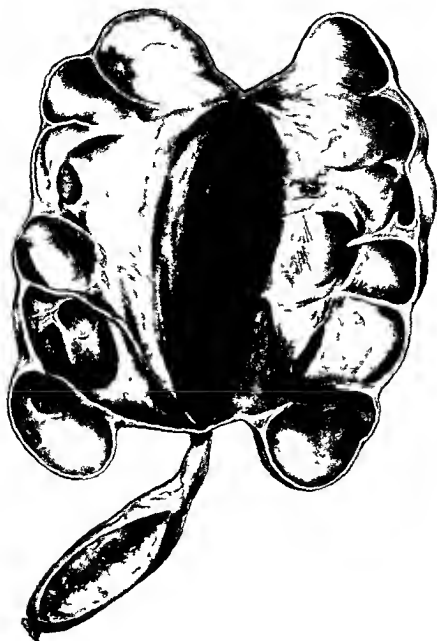


FIG. 66

Transitional celled carcinoma of the ureter. The obstruction has resulted in almost complete atrophy of renal tissue. Removed from a man aged 49.

It may be accompanied by elongated rounded clots. Blood is visible in the urine at some time in 70 per cent of cases. Pain is a variable symptom. There may be aching in the loin from distension of the renal pelvis or there may be more acute pain and colic from the passage of blood clots along the ureter. In other cases pain has been described in the lumbosacral region or in the perineum such pain being probably due to metastases or to the extension of growth beyond the ureter. A tumour may be palpated in the loin owing to renal distension and occasionally a low ureteric growth may be felt per rectum or per vaginam. In later cases there may be progressive loss of weight with increased frequency and pain on micturition.

### DIAGNOSIS

The diagnosis may be reached by a combination of cystoscopy and X ray examination. Routine cystoscopy in a case of hæmaturia will exclude a vesical lesion whilst blood may be seen coming from one ureteric orifice and in a proportion of cases a piece of growth may be seen to be extruded from the orifice sometimes showing backward and forward movement with each peristaltic contraction of the ureter (Figs 63 64 and 65). Care must be taken not to mistake a vesical tumour covering the ureteric orifice for an intra ureteric growth. There may be a change in the efflux from the orifice the stream being slow and forceless with a low placed tumour. Intravenous pyelography may very occasionally show a dilatation of the ureter ending fairly abruptly at the growth or there may be an irregular filling defect in this area. Frequently however this form of examination is unsatisfactory as the function of the kidney on the affected side is so impaired that poor excretion of dye occurs. More information may be obtained from the passage of a ureteric catheter for marked hæmorrhage may be produced when the growth is reached blood appearing both in the collected urine and in the bladder having run down outside the catheter. This fact was first noted by Chevassu and Mock (1912). If however the catheter can be successfully passed beyond the growth the urine subsequently escaping will be clear. Some radio opaque fluid should then be injected into the renal pelvis and the injection slowly continued while the catheter is gradually withdrawn so that a complete pyelo ureterographic picture is obtained when an irregular filling defect may be seen in the ureter. In those cases in which exploration of a kidney for hæmaturia does not reveal the cause of the bleeding a ureteric growth should be suspected. In some cases recurrence of hæmorrhage after removal of the kidney on the affected side has given the clue to a ureteric growth.

With the increased facilities provided by exact urological methods of examination a diagnosis of ureteric neoplasm is becoming more frequent. Unilateral hæmaturia renal discomfort and a palpably enlarged kidney are a triad of symptoms common to other diseases such as renal calculus growth, or tuberculosis. The diagnosis of these is usually made fairly obvious by complete X ray examination but papillomatous growths in the renal pelvis are frequently accompanied by secondary implantations in the ureter. The growths in the renal pelvis may be visualized as filling defects in the pyelogram. A filling defect in the ureter however is diagnostic of a primary ureteric growth only when a growth of the renal pelvis can be eliminated. Occasionally a non opaque ureteric calculus or blood clot may cause a filling defect but the ureterogram will not show such a marked degree of irregularity of outline as with a tumour.

### TREATMENT

The pre operative diagnosis between a benign and a malignant tumour of the ureter is practically impossible but the treatment of the two conditions is the same. Where the opposite kidney has been proved to be of normal functional activity the operation of choice is a complete nephro ureterectomy together with the resection of a small area of the vesical wall round the ureteric orifice. This is best carried out extraperitoneally through two incisions. First the kidney is exposed in the loin the renal vessels ligatured and divided the separated kidney and upper ureter tucked into the retroperitoneal space and the lumbar wound closed. A second incision is then made in the iliac region the muscles divided and the peritoneum stripped from the pelvic wall. The separated kidney is delivered from this incision the ureter traced down to the bladder, and the vesical resection carried out. In cases in which it is not deemed advisable to resect the terminal ureter the mucous lining of the latter should be thoroughly coagulated by diathermy to obviate the possibility of recurrence of growth.

In some cases such a radical procedure as described may not be justifiable owing to the patient's poor general condition or to the fact that the function of the opposite kidney is so impaired that nephrectomy would entail marked risk. In such cases the affected ureter might be removed first and the kidney on a later occasion or else a ureterostomy might be performed. In exceptional cases the proximal end of the ureter may be reinserted into the bladder or diverted into the pelvic colon. Hunter (1935) reported a remarkable case in which he resected the lower half of a ureter affected by carcinoma and ligatured the divided ureter, the patient refused subsequent nephrectomy. He lived for six years and then died from the perforation of a colloid carcinoma of the stomach. The kidney was reduced to a hydronephrotic sac but there was no evidence of metastasis from the ureteric growth. Owing to the frequency with which carcinoma of the ureter spreads to the regional lymphatic glands—according to Lazarus in 48 per cent of cases—a course of deep X ray therapy should be given after the operation.

### PROGNOSIS

The prognosis after operation for growths of the ureter is distinctly poor. Apart from an operative mortality of about 20 per cent few patients live for more than two years death occurring from metastases in the glands liver lungs etc. Of the sixty two cases reported by Scott in only two was there survival for more than five years. Kraft (1922) reported the case of a patient well eleven years after operation and Crance and Knickerbocker (1924 1930) the case of a patient well eight years after the removal of a squamous celled carcinoma of the lower ureter. Hunter's patient lived six years after resection of the ureter and Riches reported the case of a patient who lived for just over five years after nephro ureterectomy, although during this time there were frequent vesical recurrences treated by perurethral diathermy.

### NEW GROWTHS OF THE SUPRARENAL GLAND

Neoplasms of the suprarenal gland may arise in either its cortical or medullary portion. The adrenal cortex in common with the testis and ovary is derived from the mesoderm of the Wolffian ridge whilst the medulla is formed from elements which ultimately produce the sympathetic nervous system. In accordance with this double derivation the clinical symptoms of suprarenal



neoplasms differ largely according to their embryological origin. Evidence shows that the cortical tissue is intimately connected with development and growth particularly of the sex organs whereas the medulla influences the regulation of blood pressure and probably acts in conjunction with other ductless glands especially the pituitary. Clinically the symptoms associated with tumours of each part show alterations either of sexual characteristics or of the blood pressure.

Tumours of the suprarenal gland may be classified as —

- 1 CORTICAL TUMOURS—(a) adenoma  
(b) carcinoma
- 2 MEDULLARY TUMOURS—(a) chromaffin celled  
(b) nerve celled—neuroblastoma and ganglioneuroma

### PATHOLOGY

**Cortical tumours**—Although the suprarenal cortex is of mesodermal origin, tumours reproduce the structure of the gland, and are described as adenomata and carcinomata. Adenomata are more common, but there seems to be a distinct tendency for them when present for some time, to assume malignant characters. They form rounded masses of yellow colour, and the cut surface shows areas of hæmorrhage and necrosis very similar to those seen in renal hypernephromata. They may increase to a considerable size, large enough to form a palpable swelling in the upper abdomen. Microscopically the cells resemble those of the normal adrenal cortex, but their arrangement is atypical.

**Medullary tumours** are divisible into two types. In the chromaffin-celled group the tumour may be encapsuled and benign, or may infiltrate as a malignant growth and give rise to metastases. In both the innocent and malignant tumours an excess of adrenalin is secreted, and there are marked changes in the blood pressure. In the other main type of medullary neoplasm, the highly malignant neuroblastoma, which occurs most commonly in children, the growth is histologically found to consist of nerve cells of very immature form. These tumours give rise to early metastases. In fact, a secondary growth may be the first evidence of disease. The liver may be much enlarged (Pepper 1901), or secondary growths may appear about the orbit or the cranial bones (Hutchison, 1907). These tumours were previously looked upon as sarcomata, and it now seems probable that tumours described as retroperitoneal sarcomata in children were really neuroblastomata.

**Ganglioneuroma** is a rare medullary tumour composed of ganglion cells which lie in groups separated by bundles of medullated and non medullated nerve fibres.

### SYMPTOMS AND SIGNS

Before considering the symptoms associated with a tumour of the adrenal gland it is necessary to consider the special train of symptoms which may be produced by a neoplasm of the cortical and medullary portions separately. One of the functions of adrenal cortical tissue is to preside over the sexual activities, and in a number of cases of tumour of the cortex the sexual characteristics of the individual become altered. This is believed to be due to the excess of hormones formed by the cortical cells, and is seen both in cases of tumour and also with hyperplasia of the gland (Broster, Gardiner-Hill and Greenfield 1932). These sexual changes, known as the "adrenogenital syndrome," depend largely upon the age of the patient when the disease commences, the degree of endocrine activity, and the duration of the illness. An adult man or

woman may show little change but in a male child with a cortical tumour there is precocious development puberty commencing early Hair grows on the face body, and pubic region the genitals become enlarged and the voice deeper and there is marked muscular development

In the female child there is again precocious sexual development the pubic hair grows menstruation may occur early and the clitoris becomes hypertrophied In the young adult female there is a remarkable change towards male characteristics There is an increase of fat about the neck chest and abdomen hair appears on the upper lip and face and the pubic hair assumes the male distribution The clitoris hypertrophies and may in some cases show weak erection whilst the uterus and ovaries become atrophic and menstruation ceases Occasionally the blood pressure becomes raised According to Frank there may be excess of oestrogens in the urine with a negative pregnancy test especially with adrenal cortical carcinomata

The constitutional symptoms of a tumour of the adrenal medulla are wholly different from those of a cortical tumour and are probably due to the passage of quantities of adrenalin into the blood stream There are attacks of paroxysmal hypertension brought on by slight physical or mental exertion when the blood pressure may be raised to 250 mm. of mercury or more with tachycardia dyspnoea and headache Glycosuria may be present

A tumour of the suprarenal gland may remain small and give rise to no palpable swelling although the adrenogenital syndrome may become marked In other cases both benign and malignant tumours may attain considerable size and form a mass in the loin or subcostal areas displacing the liver or spleen In X ray examination may show the outline of the mass and the dome of the diaphragm may be slightly raised A barium meal examination may show the stomach pushed to the right or the duodenum to the left by the mass and pyelography may show the kidney to be displaced downwards or rotated upon its axis without any apparent pressure effect upon the renal pelvis or calyces In some cases X ray examination after air insufflation into the loin has demonstrated the outline of a tumour but this form of examination is not without risk In any case of suspected suprarenal tumour search should be made for secondary deposits of growth in the bones chest and liver

### DIAGNOSIS

The presence of a tumour in the upper abdomen accompanied by the adrenogenital syndrome or by paroxysmal hypertension should arouse suspicion of an adrenal neoplasm but in many cases no tumour is palpable Clinical distinction between an innocent and a malignant tumour is impossible although obvious increase in size would suggest the latter Secondary deposits in the liver or cranial bones may be present especially in the neuroblastomata of children

Other conditions besides adrenal tumour may be accompanied by the adrenogenital syndrome Broster Gardner Hill and Greenfield drew attention to the presence of the syndrome in cases of adrenal hyperplasia and state that where no tumour is palpable the diagnosis cannot be made except by exploration of both suprarenal glands Again with Cushing's basophil adenoma of the anterior portion of the pituitary gland there may be hyper activity of the adrenal cortex together with changes in the sexual characteristics—overgrowth of the hair on the face etc but in pituitary tumours the clitoris is seldom enlarged as in suprarenal growths Further with Cushing's basophil adenoma X ray examination of the skull may show enlargement of the pituitary fossa there may be changes in the optic discs and hyperglycemia may be present (Scholl)

Some ovarian tumours (arrhenoblastomata) may be accompanied by over growth of the hair of the face and body and by a tendency towards masculinization but the presence of a tumour in the lower abdomen or pelvis would suggest an ovarian growth

In those cases in which a tumour accompanied by sexual changes is palpable in the subcostal region differential diagnosis from splenic renal gastric or gall bladder tumours will usually be made by X ray examination supplemented by a barium meal pyelography or cholecystography. But in a proportion of cases the diagnosis can be reached only by an exploratory laparotomy. Hormonal changes may be present. Thus Frank reported a high concentration of oestrogenic hormone in the urine of four patients with adrenal cortical carcinoma but no increase was found in cases of adrenal hyperplasia or adenoma. Levy Simpson and Joll (1938) reported a case of excess of oestrogen in an adult male undergoing feminization from adrenal carcinoma. The excess of hormone and the feminine characters disappeared after removal of the tumour but returned when metastases appeared. Similarly Kepler Walters and Piper reported the case of an adult woman with an adrenal tumour in whom nineteen rat units of oestrin were present.

### TREATMENT

The ideal treatment for these lesions is the surgical removal of the tumour. In many cases this must be preceded by an exploratory laparotomy to ascertain which side is affected and also to exclude the presence of an ovarian tumour which may imitate male characteristics. While transthoracic and paramedian routes—the latter with a T shaped subcostal extension at right angles to the original incision—have been employed to gain access to adrenal tumours these are perhaps best approached by a high lumbar renal incision with removal of the last rib. The perinephric fatty tissue is opened the kidney displaced downwards and the adrenal gland exposed. The vascular supply enters at the medial and posterior aspect of the gland and requires careful ligation. Any operation on the suprarenal gland is apt to be followed by considerable shock which is probably due to adrenal cortical insufficiency and is combated by extracts of adrenal cortex and by the administration of sodium salts. A course of post operative deep X ray therapy would appear to be indicated.

### RESULTS

Cases have been recorded by Gordon Holmes and others in which reversion of the changed sexual characteristics has followed the removal of an adrenal tumour or in which paroxysmal hypertension has been relieved for many years after the removal of an adrenal paraganglioma. Walters and Kepler (1938) report the removal of seven adrenal carcinomata. Two were advanced having spread beyond the gland and recurred within two years but five patients in whom the tumours were apparently encapsuled remained well. Broster considers that cases occurring in the post pubertal period offer the best chance of anchorage and return to a normal sexual sphere.

### PARANEPHRIC TUMOURS

These arise in the perinephric tissues or in the true capsule of the kidney. **Ætiology**—These tumours may be rightly described as rare. They have the special peculiarity that they occur more frequently in women than in men they have been found in children also.

The origin of these neoplasms is probably from a remnant of the Wolffian body but the possibility that they arise from inclusions from other structures in the vicinity during the course of development cannot be ruled out. Certain cysts found communicating with the pelvis probably originate as buds from the ureter in the same way that the calyces occur.

**Pathological anatomy**—The common site of origin is from the tissue in front of the kidney rather than from behind or in the regions of the poles (Marion 1935). One of these tumours may reach such dimensions as to cause a considerable bulging of the abdominal wall on the corresponding side. When such a tumour arises in the true capsule of the kidney the latter soon becomes invaded. When the origin is more superficial however the tumour in the early stages remains distinct from the kidney, invading it only when the condition is well advanced. In the latter circumstances it may be impossible to be certain as to the actual origin of the growth. Any of the adjacent organs—particularly liver, spleen and bowel—is in due course likely to be involved in a direct extension of the tumour.

Three main groups of neoplasm have been identified according to their structure—

- 1 Those consisting largely of cellular, fatty, muscular or bony tissue
- 2 Epithelial tumours
- 3 Mixed tumours showing characters of both the above groups

The first group tends to undergo sarcomatous degeneration and the osteomata more than the other types are likely to gain considerable dimensions. The epithelial tumours tend towards the formation of cysts lined by cylindrical or flattened epithelium and contain fluid. These cysts may be multiple and give the impression of polycystic disease of the kidney. Sometimes a cyst is found to communicate with the renal pelvis.

The chief characteristic of the mixed tumours is that like those of the first group they have a tendency towards sarcomatous degeneration.

**Symptoms and signs**—It is only when the tumour is advanced that subjective symptoms arise from involvement of adjacent structures. They may relate to the kidney, nerves, bowel, liver and even the vena cava. A tumour which causes a bulge and can be felt in due course develops in the loin. In consistence the swelling may be soft or hard, its surface smooth or lobulated.

Growth of the mass is slow or rapid according to its nature. Certain tumours of childhood advance quickly. Malignant growths lead to death by cachexia while simple neoplasms cause manitation from their excessive size.

**Diagnosis**—It is necessary to have in mind the possibility of a paranephric tumour. It should not be difficult to discriminate between these growths and those of renal origin. If a palpable mass is present, instrumental pyelography by showing that the ureter is displaced by the mass indicates that the latter is renal or perirenal, whereas the absence of deformity of the pelvis and calyces excludes a growth of renal origin. Further confirmation of the presence of a paranephric tumour will be forthcoming from evidence of unimpaired function of the kidney in question.

Other factors which would support the diagnosis that the mass is paranephric are the following: considerable size, softness and a situation behind the colon. In due course atrophy from pressure may bring about diminution of the renal function.

**Treatment**—The only course offering a prospect of cure is complete extirpation of the growth. These tumours however often attain such considerable dimensions that their removal is a matter of grave risk to the patient's life.

the operative mortality in this type of case being as high as 50 per cent. With the patients who survive recurrence often takes place rapidly. In these circumstances non-operative treatment is often a wise course and radiation therapy is a reasonable alternative.

Where the growth is not unduly large, the prognosis from removal is good. The surgical approach by way of the loin gives satisfactory access in the latter type but in the former the abdominal route is sometimes expedient. A good exposure is necessary so as to avoid leaving behind any of the growth.

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(Revised by ALEX. E. ROCHE)

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## CHAPTER XII

### NEPHRITIS FROM THE SURGICAL POINT OF VIEW (THE SURGERY OF NEPHRITIS)

**N**EPHRITIS (Bright's disease) is from the therapeutic standpoint an essentially medical problem and rarely comes within the sphere of surgery. During the course of the disease however certain crises may arise which should they fail to respond to medical measures occasionally react to operative therapy. At one time renal decapsulation enjoyed a considerable vogue but physicians rarely recommend it now and should they *do so* there appears to be little unanimity of opinion in regard to the exact indications for the operation.

In addition to true nephritis (as that disease is now understood) there are certain other symptom complexes which may be associated with more especially focal types of nephritis. Nephralgia (nephritis with pain nephritis dolorosa) and essential hæmaturia (nephritis with hæmaturia hæmaturic nephritis) come within this category and are the direct concern of surgical urology.

#### THE EVOLUTION OF OPERATIVE TREATMENT

The pathological changes which affect renal function in nephritis are predominantly vascular in character. In acute cases engorgement and stasis cause damage to the glomeruli and tubular cells oedema and tension. In chronic cases there is vascular sclerosis and occlusion with fibrotic replacement of the functioning units. The aim of operative treatment has therefore been to mitigate as far as possible the effects of these vascular errors.

Following upon Reginald Harrison's pioneer work at the close of last century Edebohls in 1904 published his results of decapsulation. He claimed that the removal of the capsule is followed by the formation of extensive new vascular connections between the kidney and its fatty capsule by the absorption of inflammatory products and by a new growth of epithelium capable of secretory function. In a series of seventy two cases he claimed improvement in forty three amongst which seventeen patients were classified as cured ten being cases of chronic interstitial nephritis. Though others including Rovsing reported favourably on their results further experience failed to corroborate these original claims and the operation accordingly became largely discredited except for the treatment of very selected cases mainly of an acute or subacute character associated with oedema and signs of impending renal failure.

The theories advanced by Edebohls are open to considerable doubt. The thick adherent adventitious capsule which rapidly encircles the kidney may be highly vascularized but it is questionable if the new blood supply thus created can do much more than compensate for the original intercommunications between the renal and perirenal vascular channels. Again prolongations of this capsular fibrous tissue into the kidney cortex may indeed serve to accentuate any interstitial changes already present.

Further suggestions to explain the effects of decapsulation include Volhard's theory of protein shock induced by liberation of fluids from the decapsulated organ, Sens' lymph drainage theory and the supposition that the relief of intrarenal tension and free drainage from the wound are the main factors.

The finding that the renal capsule contains vasoconstrictor and afferent sympathetic nerve fibres has suggested that a major effect of decapsulation is to interrupt these fibres and so bring about a partial denervation of the kidney. This would serve to reduce vasomotor spasm and thereby aid the elimination of toxins causing damage to the excretory cells while the division of the afferent fibres would in part explain the benefits of the operation in cases of nephralgia.

A more radical form of denervation of the kidney has now been developed. The main sympathetic nerve supply comes from the renal plexus which receives branches from the splanchnics through the semilunar ganglion while there is also a contribution from the first lumbar ganglion (Fig 67). Most of the fibres lie in relation to the adventitia of the renal arteries and can therefore be interrupted by a periarterial sympathectomy. This denervation of the renal pedicle produces vasodilatation with increased blood flow and a subsequent diuresis of low specific gravity, relaxation of the sphincters including that at the ureteropelvic junction and the ring muscles round the renal papillæ (Fig 68) and renal anaesthesia. The operation has been shown to have virtually no harmful effects on the kidneys and was first practised in 1921 by Papin who recommended it for the relief of pain in chronic nephritis, for small hydro-nephroses and for nephralgias of unexplained origin. Favourable results have also been claimed in cases of essential hæmaturia but it is a meticulous operation and hardly suitable for emergency cases of renal failure in nephritis.

### RENAL ASPECTS OF HYPERTENSION

The modern concept of hypertension is that it is not in itself a disease entity but is a sign of a progressive vascular disturbance common to a large number of disorders which may be grouped into those of extra renal origin and those directly attributable to renal ischæmia. Much credit goes to Goldblatt for his fundamental observations. He demonstrated that compression of a main renal artery sufficient to decrease the blood flow through one kidney invariably leads to elevation of the blood pressure and that removal of this ischemic kidney relieves the hypertension while excision of the normal kidney perpetuates it. The hypertension is attributed to the elaboration of a pressor substance since extracted as renin which is activated in the blood stream and causes peripheral vasoconstriction independent of nervous influences.

The causes of renal ischæmia may be grouped according to Gilchrist as *A* Occlusive vascular disease, *B* Primary renal disease, *C* Impedance to urinary outflow—hydronephrosis. Chief interest to the surgeon centres round groups *B* and *C* especially when they are unilateral. The commonest disease in group *B* is chronic pyelonephritis where the progressive inflammatory process leads to obliterative vascular changes in the kidney and later hypertension. Hydronephrosis always leads to distortion of the blood vessels and ischæmia.

These facts point to the importance of a complete urological investigation in cases of hypertension especially when they occur in young subjects in whom pressure changes are of only a few years standing. If a unilateral hydronephrosis or chronic pyelonephritis with pyelectasis can be demonstrated nephrectomy may be performed with a reasonable hope of lowering the pressure.

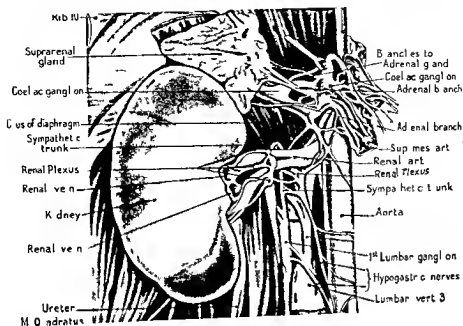


FIG 67

Nerve supply of the kidney Photograph of a dissect on in the Department of Anatomy of the Medical School of the University of Sydney (S. H. Harris and R. G. S. Harris)

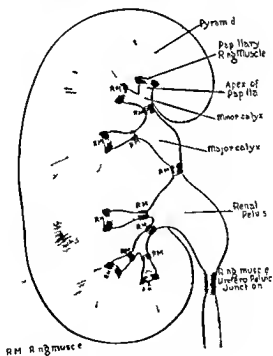


FIG 68

Renal muscle system of the renal pelvis and calyces after Max Brodel (S. H. Harris and R. G. S. Harris)



Focal nephritis is associated clinically with hæmaturia nephrosis with œdema and sclerosis with hypertension. All three signs are met with in glomerulo-nephritis.

In general surgical intervention in the form of decapsulation is called for only in the event of serious emergency to tide the patient over an acute phase of progressive oliguria associated with a continued low specific gravity of the urine which threatens or culminates in actual anuria with impending uræmia. Owing to improved methods in medical treatment including intravenous therapy with non threshold drugs such as sodium sulphate operation is rarely undertaken. The operation *per se* is not curative and affects little if at all the general course of the disease. It follows that the ultimate outlook is better in acute or subacute cases and in young subjects. An anuria coming on in a case of established chronic interstitial nephritis with previous evidences of cardiac hypertrophy hypertension and azotæmia can hardly be looked upon as an indication for surgical treatment.

**Diffuse glomerulonephritis**—Probably the most striking results of surgical treatment in this group have been obtained in subacute cases (subacute parenchymatous nephritis) in which the nephrotic syndrome as evidenced by œdema is prominent. Decapsulation however is indicated only in the presence of progressive oliguria or anuria. Patients frequently stand a unilateral or bilateral operation relatively well and if successful the subsequent diuresis is rapidly established. Clinical improvement with disappearance of the œdema may be manifest but without the blood pressure readings or renal function tests being materially affected and relapses must be looked for.

**Focal nephritis**—The acute embolic type of focal nephritis is not a true nephritis in the proper sense of the term. It embraces such conditions as carbuncle of the kidney and bilateral septic infarction, which do not call for consideration here. The chronic non embolic type is a focal glomerulo-nephritis which may be found in such conditions as nephralgia or essential hæmaturia and will be dealt with later.

**Toxæmic kidney**—Mild cases are usually due to a bacterial toxæmia and constitute the so called febrile albuminurias. The really severe cases are caused by potent exogenous or endogenous poisons. Among the former the best known example is perchloride of mercury while examples of the latter are found in eclampsia severe burns and the recently described crush syndrome (Bywaters and Beall 1941). Here the chief pathological change is severe degeneration of the convoluted tubules with exfoliation of the epithelium (necrotic nephrosis). The clinical manifestations include those of progressive renal failure with oliguria and anuria. A certain number of successes have been achieved from decapsulation but not infrequently there are additional gross changes in other organs such as the liver which vitiate any improvement likely to arise from the operation.

**Nephrosis**—Apart from the foregoing there are the chronic forms of nephrosis such as the amyloid type and the pure lipoid variety the latter associated with a cholesteræmia. Neither of these two conditions is benefited by surgery.

**Vascular diseases**—In these chronic forms of nephritis attempts have been made to improve the blood supply of the kidneys and reduce hypertension by such operations as nephroomentorexy and nephromyopexy using omental or muscle pedicle grafts to wrap round the decapsulated organs.

The results of these operations have been uniformly poor and they cannot be recommended.

## NEPHRALGIA

## (Nephritis with pain Nephritis dolorosa)

The predominant feature in this condition is a more or less severe and persistent type of renal pain which is usually unilateral and is not associated with clinical evidences of nephritis or other major pathological lesion sufficient in itself to account for the symptoms

**Ætiology**—This is frequently obscure but the history may point to a previous infection focal nephritis or injury to the kidney. The patients are usually women of a nervous temperament between 20 and 40 years of age and there are often indications of inflammatory or other disease in the pelvic organs. Displacements of the kidney may play a part while a more novel conception of the condition is that in some cases it is due to derangements of the sympathetic control of the kidney and its pelvis the renal sympathetico tonus described by Harris (1935)

**Pathology**—The kidney may appear normal or show areas of thickening and opacity in the capsule subcapsular cysts and perinephritis with fibrosis and adhesions in the perirenal fat. In such cases the microscope will reveal areas of focal nephritis in the renal parenchyma. Slight degrees of hydro nephrosis ureteric kinks and strictures may be present as concomitant anomalies

The condition of renal sympathetico tonus postulates an overactivity of the sympathetic nerve supply resulting in a neuromuscular dysfunction with obstruction and faulty drainage of the renal pelvis. This may be demonstrated by a delay in the emptying time even when the pelvis is of normal size. The normal rate of emptying is about 1 c.c. per min. and an approximate estimate of the rate for any given case can be made by noting the time required for the pyelographic shadow to disappear after withdrawal of the catheter a known quantity of fluid having been injected. Harris described three stages of this disease syndrome (1) the stage of irritability or systole (2) the stage of diastole or exhaustion and (3) the stage of paralysis or hydronephrosis

**Symptoms**—The one essential symptom is pain in the renal distribution which may be intermittent dull and continuous but with exacerbations or take the form of acute colic. There is tenderness in the costo vertebral angle and the kidney may be displaced. Disturbances of micturition are not necessarily present and the urine usually shows no abnormal constituents though hematuria may be met with. If the pain is right sided it will frequently be found that the appendix has already been removed

**Diagnosis**—Pain of a more or less renal type is a common complaint and care is needed before a reasoned diagnosis of nephralgia is arrived at. Referred pain from the spine or spinal musculature gall bladder disease and affections of the uterus or adnexa will have to be taken into account in the differential diagnosis while feet capable of causing toxic absorption should be sought for. When the symptoms are of short duration the possibility of an abdominal carcinoma may require to be considered. A full investigation of the urinary tract is necessary and pyelography in the vertical position may be helpful in demonstrating renal ptosis or kinking of the ureter. A slight degree of hydro nephrosis will favour the diagnosis as will reproduction of the pain on filling the pelvis while any delay in the emptying time should be noted. Harris recommended the hypodermic injection of eserine  $\frac{1}{10}$  gr. to differentiate between pain due to a neuromuscular obstruction and that due to an organic one. In the former rapid relief obtains

**Treatment**—Even when the diagnosis is reasonably established conservative measures, including ureteric dilatation and renal lavage, should still be continued, and only when these fail should operation be advised. The operation of choice is either a decapsulation or the more radical denervation of the renal pedicle. Coincidentally such accompanying conditions as ureteric kinks or nephroptosis can be rectified. Many surgeons, including those of the Italian school, claim that decapsulation is sufficient to afford relief, but cases of failure have been quoted in which subsequent denervation has proved successful. It would appear reasonable to employ the latter method when a commencing hydronephrosis has been demonstrated.

In the operation of renal denervation a free exposure is required and initial difficulties may be encountered from fibrotic adhesions or an abnormally short pedicle. The kidney and upper end of the ureter are completely freed and the pedicle is stripped laterally from near its mesial end. Great care is taken of the thin-walled renal vein as injury to this may necessitate nephrectomy. Oldham (1935) recommends that subsequently the pedicle should be swabbed with 10 per cent phenol which will destroy small nerve filaments missed in the dissection, or will show up larger fibres that can now be divided. Some surgeons claim that such a chemical denervation is sufficient without the necessity of an actual dissection and division of the nerves.

## ESSENTIAL HÆMATURIA

### (Hæmaturic Nephritis)

This somewhat rare condition is characterized by more or less severe intermittent bleeding from kidneys which otherwise appear relatively healthy. Much controversy has ranged round the subject, and some urologists go so far as to deny its existence, claiming that the acceptance of the diagnosis constitutes a confession of failure to elucidate the true cause of the hæmorrhage. Statistics show, however, that if the diagnosis be made on sufficiently accurate data this form of bleeding does not portend the likely development later of carcinoma or other serious disease in the kidney.

**Ætiology**—Though largely indeterminate various ætiological factors of a local and general nature have been suggested. Renal displacements, nephritis or other inflammatory diseases, and spasmodic errors of the papillary ring muscles are among the former. Focal infection, particularly in the nasopharynx, and blood dyscrasias, possibly associated with lowered platelet counts have been cited among the latter. Hypertension when present, is probably of subsidiary importance. Some general factor is certainly probable if both kidneys are affected.

**Pathology**—Little if any pathological change beyond vascular congestion may be discovered even in a kidney excised for excessive hæmorrhage. Diffuse parenchymatous nephritis is very rare, though areas of focal nephritis are more commonly found. Attention has been specially directed to the papillæ where small varices or angiomas possibly related to spasmodic dysfunction of the papillary ring muscles have been demonstrated. Local inflammatory reactions (papillitis) and interstitial hæmorrhages are frequently associated with these telangiectatic changes, while the actual hæmaturia is evidently due to their close proximity to the walls of the renal pelvis. There is sometimes marked thickening and condensation of the peripelvic fat, sufficient perhaps to cause some degree of venous congestion (Figs 70 and 71).

**Symptoms and signs**—Men are more commonly affected than women, the average age being about 45 years. The onset of hæmaturia is usually sudden



FIG 70

Whole section of affected left kidney showing overgrowth of peripelvic fat venous dilatation and hæmorrhages



FIG 71

Section of cortex of above kidney ( $\times 100$ ) showing chronic venous congestion but little if any interstitial nephritis

Essential hæmaturia male aged 45 Almost continuous painless hæmaturia for twenty years Finally clot colic No urinary infection

hysterectomy No recurrence (Sir Henry Wade's case)

and painless though there may be an ache and tenderness in the loin or actual colic due to the rather uncommon formation and downward passage of clots. The first attack is followed by others which appear at times to be incited by chill or trauma and which tend to become more prolonged over a course even of years with comparatively little upset. Occasionally the bleeding may suddenly become profuse and dangerous.

There is no organismal infection in the urine and between attacks it is the exception to find any objective or laboratory evidences of chronic nephritis.

**Diagnosis**—Cystoscopy should if possible be carried out during an attack of hæmaturia to exclude the presence of a vesical lesion and to indicate which kidney is bleeding.

The history is helpful especially if there have been several previous attacks over a prolonged period without the development of a palpable tumour and if it is known that both kidneys have been affected either simultaneously or consecutively. The following three criteria for a positive diagnosis are given by Priestley and Wilbur (1934)—(1) Both kidneys must have normal function. (2) Both must give normal retrograde pyelograms. (3) There must be no evidence of infection in either kidney. This is not strictly accurate as the pyelogram may show a temporary filling defect or a pyelectasis due to clots filling the pelvis or obstructing its outlet. If there is doubt on this score pyelography should be repeated after an interval of a week or two.

In the differential diagnosis all other causes of renal hæmorrhage must if possible be excluded especially acute Bright's disease, tuberculous and other infections, fixed stones and tumours. It is very rare for even an early renal tumour not to show some persistent pyelographic deformity but a small papilloma of the ureter which may have bled centrally can easily be missed if it does not obstruct the passage of the ureteric catheter. The investigation should include complete blood studies to exclude the presence of hæmatogenous disease.

**Treatment**—Accurate diagnosis and the known facts concerning prognosis will determine the appropriate treatment while the characteristic intermittency of the bleeding should be taken into account when estimating the results of any one line of therapy.

Treatment should be primarily conservative. Any discoverable septic foci should be eradicated and therapy for avitaminosis instituted if such a condition is indicated. Locally pelvic instillations with 1 to 5 per cent silver nitrate solutions usually prove effective.

Should the bleeding become so profuse as to endanger life nephrectomy will be required while it may also be justified in very protracted cases of less severity where the hæmorrhage has always been confined to one side. In the average relatively severe case however provided that conservative measures fail renal decapsulation can be recommended as giving satisfactory results in over 70 per cent of cases. Denervation of the renal pedicle has also been reported as proving satisfactory and should the bleeding be primarily due to spastic states of the papillary ring muscles it would seem that this operation is well founded.

R. LESLIE STEWART

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## CHAPTER XIII

### OPERATIONS ON THE KIDNEY

#### POSITION OF THE PATIENT

THE patient lies with the side to be operated upon uppermost and it should be fully extended. Modern tables are designed to meet this requirement some having a built-in screw operated bridge placed transversely about the middle of the table. Other tables are made to break (Fig 72) the head and foot falling downwards. On the whole this latter design will give better operating conditions as the patient's head and foot reach lower points and produce firmer extension on the flank. A large pillow or an air cushion was used in days gone by to raise the loin. Even an air

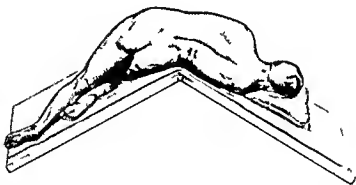


FIG 72

Patient in position on table. Note—(1) The exact relationship of the break in the table to the patient's flank—it is immediately under his last rib. (2) The body is quite close to the edge of the table ensuring easy access for the surgeon. (3) The left loin is kept high and is not allowed to flop forwards. (4) The acute angle made by the table. (5) The pillow is small and supports only the head. Extension of the flank is thus not interfered with.

cushion is greatly inferior to a metal support as it lacks the necessary rigidity. The patient's upper leg is fully extended and the underneath one is steeply flexed on the trunk. By these means the body is retained in a fairly good and stable position but on the better tables various movable rubber-padded supports are provided which maintain this position rigidly and prevent the trunk from sagging forwards or backwards. In the absence of such mechanical aids one or two judiciously placed pillows will go far to meet the case. Precision in placing the patient is important and may make all the difference between an easy and a turbulent operation. Be particular that the correct part of the patient's trunk—the eleventh and twelfth ribs of the underside—is accurately related to the elevation in the table as there is little or no margin for error or variation if the fullest exposure of the operation area is to be

incision when healed does not overlie and adhere to the iliac crest as is the case with the usually described incision. If necessary it can easily be extended backwards and upwards over the rib, or forwards, or downwards, as will be described later. The wound is now deepened till the muscular layers are reached. In stout patients it is quite easy to stray from the correct line and in such subjects it is wise periodically to identify the twelfth rib afresh so as to confirm one's position.

The incision should from the first be planned to allow the easy delivery of a normal kidney. A few writers recommend smaller incisions for conditions such as pelvic stones and movable kidneys, the intention being not to mobilize the kidney fully. It is always unsatisfactory in renal surgery not to have the kidney fully exteriorized.

### PARIETAL STRUCTURES

In the posterior angle of the incision the most superficial muscle is the latissimus dorsi. Immediately in front of this muscle and partly overlapped by it is the external oblique muscle of the abdominal wall. The fibres of these two muscles intersect each other at an acute angle. The knife is carried through them in the length of the incision passing in the back part of the wound almost transversely across both muscles, in the middle section obliquely across the fibres of the external oblique, and in the most anteriorly placed section of the wound it is usually possible to split the external oblique in the direction of its fasciculi and so minimize trauma. The incision in the muscles is designed to lie near to the costal margin, keeping, however, constantly in mind the need to leave a sufficiency of tissue for the subsequent closure of the wound. The optimum distance is  $\frac{1}{2}$  to  $\frac{3}{4}$  in.

Beneath the external oblique the internal oblique is unmistakable, its somewhat coarse bundles sloping downwards and backwards. The posterior, slightly bowed, free margin of this muscle is generally quite evident. More care is required in dividing the internal oblique than was necessary in the case of the external because of its relationship to the nerves and vessels of the abdominal wall.

**Variations in position of the twelfth dorsal nerve**—In anatomical textbooks the anterior branches of the dorsal and lumbar nerves are described as running between the internal oblique and the transversalis muscles. At operation the last dorsal nerve, which is the one principally encountered, is found to have pierced the internal oblique and to lie within its deeper layers. Actually the distribution of this nerve is inconstant (see also p. 147), three principal variations being met with according as it pursues a high, an intermediate, or a low (posterior) course —

- 1 In the first or high position the nerve, on leaving the shelter of the last rib, courses forwards, maintaining a position above the line of the incision and perhaps sending one or two small rami downwards. In this case it gives little or no trouble to the operator, being well out of the way and indeed it may never be seen at all.

- 2 In the intermediate position the nerve crosses the incision from above downwards and forwards in an oblique direction. Two main branches are usually recognizable of which the more posterior crosses the wound about its mid-point, whilst the second is found in the most anterior inch or so. It is this distribution that gives the greatest amount of operative trouble, and constant vigilance must be exercised if nerve damage is to be avoided. As above stated the nerve appears to lie in the deeper levels of the internal oblique,

its course being more or less at right angles to the fibres of that muscle. It is accompanied by vessels which for the most part occupy a superior position. Usually with care the surgeon can see the nerve gleaming through the muscle bundles and the direction taken also serves to distinguish it. Not infrequently the accompanying blood vessels are injured before the nerve itself is identified and I find that any but an experienced assistant is likely when seizing the vessel to include the nerve in the grasp of the artery forceps the more so as the latter is hidden from view by extravasated blood. In this particular area special care should be employed in the seizing of bleeding points and every effort should be made to avoid injury to these nerves. Generally both ends of the accompanying vessels require a ligature after which the surgeon frees the nerve from surrounding muscle. By judicious dissection it is usually possible to displace a nerve either forwards or backwards and thus to make it take up a position where it will not interfere with the subsequent stages of the operation. The writer stresses the preservation of these nerves as they are often carelessly and even wantonly destroyed. Their loss causes an area of anesthesia in front of the anterior superior iliac spine which patients find troublesome and sometimes painful and a muscular bulge in the same position which can be demonstrated by asking the patient to cough. Some surgeons own to an area of anesthesia the size of one's palm as a routine finding but this can be avoided with a little care.

3 The nerve runs a posterior or low course and is easily drawn back into the posterior angle of the wound.

Another nerve is to be seen coursing downwards beneath the fascia covering the anterior surface of the quadratus lumborum muscle and about  $\frac{1}{2}$  in from its outer margin. This is the iliohypogastric nerve (Fig. 73) which at operation appears to emerge from that muscle at a point higher than that usually figured in anatomical textbooks. It is in full view and should easily be avoided if the edge of the muscle has to be notched (see later).

The internal oblique and transversalis muscles.—The internal oblique is divided throughout the length of the incision and it will be noticed that in the most anterior part of the wound the upper fibres retract strongly under the overhanging external oblique.

The transversalis abdominis muscle is now exposed to view. Its fleshy fibres as seen in the front part of the wound will be observed to give place to an aponeurosis posteriorly. The fibres whether muscular or aponeurotic follow the line of the wound accurately. Half an inch below the last rib a small slit is made in the tendinous part of the transversalis (Fig. 75 (B)) and by digital traction this is rapidly extended to the whole length of the wound. Posteriorly the aponeurosis splits into three laminae through which it gains attachment to the spine and in so doing forms two compartments within which are enclosed the bulky erector spinae posteriorly and the smaller quadratus lumborum anteriorly (Fig. 74). With the point of the scalpel these two compartments are opened up and the three limbs of the aponeurosis are exposed.

A reminder of the anatomy of this region so highly important to the surgeon may not be misplaced. As an important underlying factor it must be appreciated that this is an area which has undergone profound evolutionary changes and that as in other comparable situations the various structures entering into it show considerable variability. This is well exemplified in the inconstancy of the lowest costal elements the lumbarcostal ligament and the level of descent of the pleura. To most of these further reference will be made whilst the erratic course of the last dorsal nerve has already been noted.



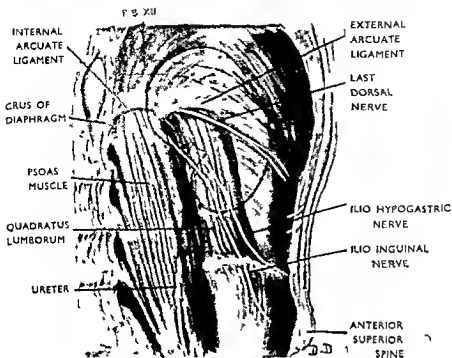


FIG 73  
Dissection showing the immediate posterior relations of the renal fossa

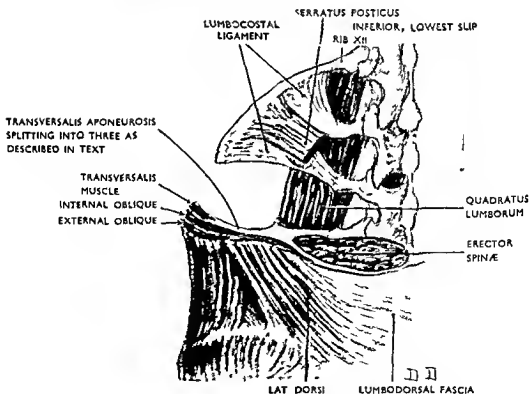


FIG 74  
Dissection showing ligamentous and aponeurotic relations posteriorly to the kidney

The external arcuate ligament and the lumbocostal ligament—Of the three laminae formed by the splitting of the transversalis fascia just described the anterior and middle constitute respectively the anterior and posterior coverings of the quadratus lumborum. Of these the more posteriorly placed is much the stronger the anterior one being so weak that it is often ignored in anatomical descriptions. The principal insertion of the quadratus lumborum is into the lower border of the inner half of the last rib. Both its fascial coverings

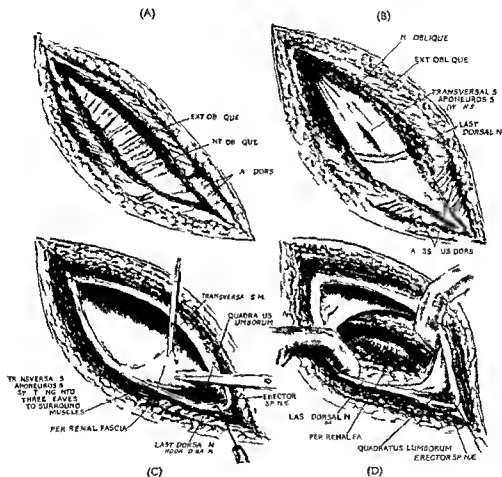


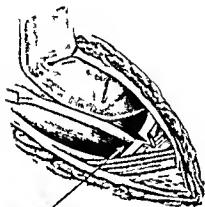
FIG 73  
Stages in the approach to the kidney

are materially reinforced in their upper regions the anterior reinforcement forming the external arcuate ligament and the one behind the muscle constituting the lumbocostal ligament. The former ligament is attached to the last rib just external to the outer margin of the quadratus lumborum and arches over that muscle to receive attachment to the transverse process of the first lumbar vertebra. It constitutes one of the origins of the diaphragm and under its arch the last dorsal nerve and vessels emerge (Fig 73).

The pleura and the last rib—The descent of the pleura below the last rib is constantly referred to in urological writings and is noted as a danger zone. The descent of the pleura occurs along the line of the external arcuate ligament

the edge of the pleural sac insinuating itself between that ligament in front of it and the topmost inch or so of the quadratus lumborum together with the last rib into which it is inserted behind it. The pleura therefore is sheltered behind these structures and is quite safe if they are not interfered with.

A statement has become current in several British works that this ligament must be divided to mobilize the rib. Presumably the authors really had in mind the lumbocostal ligament (Fig 74) for the kidney overlies the external arcuate ligament and would have to be raised and possibly exteriorized before the latter could be cut after which its division would appear supererogatory. In any case the direction of the ligament and of the last rib are so nearly parallel that little space would be gained. The pleura would obviously be in immediate danger. When the last rib is removed for the purpose of enlarging an incision the external arcuate ligament loses one of its skeletal attachments. The resection is performed subperiosteally from behind and the ligament is not actually seen. As the periosteum is a membrane of some toughness it is easily reflected without injury to subjacent structures.



CUTTING SERRATUS POSTICUS  
INFERIOR AND LUMBOCOSTAL  
LIGAMENT

FIG 76

The lower border of the lumbocostal ligament (Fig 74) (the only part interesting to the urologist) runs behind the quadratus lumborum from the transverse process of the first or second lumbar vertebra to the lowest rib. It is quite variable in its development and when the last rib is short it may extend to the eleventh.

**The serratus posterior inferior**—In contact with this ligament posteriorly is the serratus posterior inferior muscle (Fig 74) whose lower margin extends along a line drawn from the spinous process of the second or third lumbar vertebra to the last rib beyond its angle. The lower margins of the two aforementioned structures therefore follow a roughly similar line. In their inner extent they are of course

separated from each other by the bulky erector spinae muscle. They bind down the twelfth rib and if the full value of the incision is to be gained the scalpel must notch their margins (Fig 76). A finger of the left hand elevates the rib putting both structures tightly on the stretch. When they are incised the mobility of the bone is increased.

Three structures are exposed to injury by this procedure. (1) The last dorsal nerve. It may be caught as it lies close below the last rib. In this part of its course it is not easily seen but the accident can be avoided by keeping the blade  $\frac{1}{2}$  in below the rib. (2) The iliohypogastric nerve runs along the full view and with ordinary care should be seen and avoided. (3) The pleura descends below the level of the twelfth rib at the inner end. It rarely comes down more than  $\frac{1}{2}$  in and unless the notch is unnecessarily close to the rib and unnecessarily deep the pleura will not suffer.

#### INTIMATE RELATIONS OF THE KIDNEY

**The perirenal fascia**—The perirenal incision is now adequate for ordinary needs but the kidney is still hidden from view by the perirenal fascia (Fig 77).

(fascia of Zuckerhandl) Displacing some loose fat (pararenal fat) in the posterior angle of the wound a moderately firm smooth fascia, somewhat similar in appearance to the outer surface of the peritoneum, will become evident. This fascia which is a very definite anatomical structure, fuses anteriorly with the deep aspect of the peritoneum and the two are here confluent and indistinguishable, but if the surgeon picks it up with forceps (Fig 75 (D)) and snips it with scissors far back near the quadratus lumborum the peritoneum will be out of harm's way. The small rent thus formed can be rapidly extended by finger traction in a vertical direction (Fig 75 (C)) and a well defined space is entered filled with loose perirenal fat.

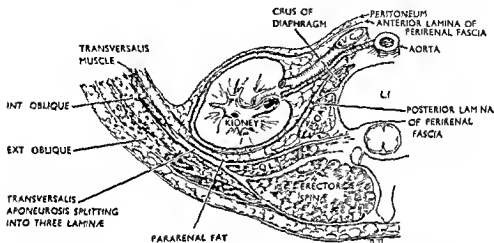


FIG 77

Transverse section of the body at the level of the first lumbar vertebra to show relationships of the kidneys and especially of the perirenal fascia. Note its course antero-externally to fuse with the peritoneum.

The fascia which has just been incised constitutes a loose pocket or sac and contains the perirenal fat within which the kidney moves. It has a pre-renal and a post renal lamina and these are continuous externally. Above the kidney and its adjacent adrenal the two leaves of the fascia unite and extend upwards to be attached to the central tendon of the diaphragm whilst below they remain open as far as the false bony pelvis where they fade off and fuse with surrounding fasciae. The course of the ureter lies between these latter prolongations. Traced inwards the posterior leaf is found to be attached to the vertebral column, whilst the anterior leaf, closely related to the peritoneum, passes over the renal hilum and blood vessels to cross the mid line in front of the great vessels to become continuous with the fascia of the opposite side.

Between the deep surface of the perirenal fascia and the capsule of the kidney pass numerous fibrous strands which loosely unite these two structures. In the interstices the perirenal fat is lodged. These strands are specially developed at the renal poles. At the upper pole quite strong fibres pass to the apex of the sac where they, like the perirenal fascia itself, are attached to the central tendon of the diaphragm. They play an important part in holding the kidney in position. The greater development of fibrous tissue at the poles is quite evident at operation, there is less fat in these positions and the connective tissue strips less easily than that in other situations. Other strands connect

the pre renal and post renal lumens and form accessory supports or hammocks for the kidney.

As the perirenal fat is displaced digitally the smooth purplish surface of the outer border or lower pole of the kidney comes into view and the finger keeping close to the capsule sweeps the slightly adherent fat from the parts which are most easily accessible commencing with its front and back surfaces. A few vessels not of any great size are seen in this fat. When torn through with the finger even the larger ones rarely bleed so that it is a waste of time to clamp and tie them. Soon it is possible to seize the organ and draw it towards the wound. Occasionally strands of connective tissue are divided with scissors the assistant meanwhile rendering them taut by gentle traction with forceps (Fig. 76 (1)). The well defined fibrous tissue at the lower pole already alluded to may be seized with forceps and can be used to draw the lower pole up to the surface. A close look out must be maintained for the ureter at this stage. It lies hidden in loose fat similar to that covering the kidney but can usually be felt or it comes into view as the fat is gently dislodged.

**The suprarenal gland.**—The upper pole of the kidney even when not pathologically changed is mildly adherent as previously explained but is easily dealt with by digital dissection and indeed one is almost entirely dependent on tactile sense at this stage. The suprarenal gland closely applied to the upper pole is in relationship to the internal rather than to the upper border and its foremost portion extends well down towards the renal hilum. The suprarenal must be left behind in the adjacent perinephric fat where its peculiar bright golden yellow colour and granular appearance is distinctive. It is not generally seen until the kidney is delivered but with care in keeping the dissecting finger close to the upper pole injury to the gland is unusual apart from the occurrence of pathological adhesion. When this is present a portion of the gland may tear away on the kidney. In only one case following a renal operation have I known symptoms of suprarenal insufficiency to supervene. This patient developed Addison's disease some years after a nephrectomy for tuberculosis and the operation may not in any way have been responsible. Evidence of suprarenal damage is therefore very rare but its possibility must be kept in mind particularly when bilateral operations are contemplated.

**Vessels at the upper pole of the kidney.**—At the upper pole of the kidney one often finds a leash of vessels generally of small size sinking into the parenchyma above the hilum and passing upwards to reach the aorta and vena cava at a high level. Before the kidney can be fully mobilized these rather inaccessible vessels will require to be divided. No anxiety for the vitality of the part supplied need be felt. The vessels should be immediately tied for it is a mistake to have artery forceps complicating a deep wound.

The kidney is now free and can be delivered on to the loin. Sometimes it is found easier to handle it with two straps to support it and sometimes without. Straps are best made of gauze folded in four thicknesses  $1\frac{1}{2}$  in in width and about 10 in in length—but of course the length will vary with the size of the kidney. The width of the straps is important as if they are too narrow they roll up and become string like whilst broad ones are clumsy and obstructive. The straps are passed above and below the renal pedicle and the free ends are crossed (Fig. 75 (2)) and held by the assistant.

### PYELOTOMY

The pelvis is frequently the objective of the operation. The most common reason is removal of renal or pelvic stones but plastic operations on the pelvis

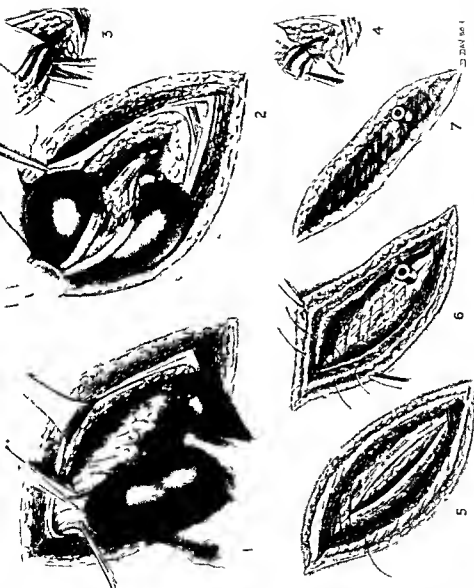


FIG. 78  
 Stages in nephrectomy (1) The kidney partly delivered. Connective tissue strands at poles being rendered taut by Wells forceps and divided. (2) Kidney delivered and supported by straps. Ureter has been ligatured and divided. Renal vessels are ligatured *en masse* leaving room for easy division. No clamp is employed. (3) Dividing the vessels. Gauze underlying them. Wells between ligature and point of section to avoid sudden retraction of stump. (4) Kidney removed. Stump being examined. (5) Continuous suture of transversalis commencing. (6) Transversalis suture complete. Drains in position. First two interrupted sutures inserted in the oblique muscles.

wall, the division of constricting and abnormal blood vessels, etc., call for its exposure. To reach it the kidney is laid well forward over the rib margin and the ureter is raised by a sling. One or two vessels ramify in the retroperitoneal fat and may need a ligature, but rarely cause much trouble. At the hilum the pelvis is the most posteriorly placed structure, the main blood supply lying in front of it, though a single small branch is usually found on its dorsal aspect. The fat which surrounds the pelvis is carefully divided and turned aside as it may subsequently prove useful to cover a suture line.

The rich blood supply of the pelvis and ureter puts them amongst the best healing structures in the human body and indeed in this respect they are probably second only to the peritoneum itself. When closing a pelvic wound the margins are drawn together by the finest catgut sutures (atraumatic needle) which are carefully placed so as to exclude the mucosa, and slightly invert the wall of the pelvis. Immediate healing is the rule. If a layer of fat has been preserved and is drawn across to support the suture line leakage is almost unknown in the presence of sterile urine, and is unusual even when mild infection is present.

### NEPHRECTOMY

When the removal of the kidney is decided upon, the exposure of the organ is carried out as described above, but it proceeds into the deeper parts of the wound to clear the constituents of the pedicle. The kidney is firmly elevated into the wound by straps and the surgeon works alternately on the front and on the back, good retraction ensuring the best access to these important structures.

The ureter may with advantage be divided early. When identified it is cleared of surrounding fat, divided between two pairs of artery forceps and tied. In cases of tuberculous disease, or papillomatous disease of the ureter or pelvis it must be divided by diathermy and the free end outside the ligature must be devitalized.

Traction on the kidney should be firm, yet elastic and light. Only once, and then when assisting a colleague, has the author seen a renal pedicle tear away. With proper care this should be the rarest of accidents. It should be realized that traction on the kidney causes considerable lateral displacement of the great vessels, and may in elderly or feeble patients cause some cardiac embarrassment through obstruction both to the arterial and venous circulations. As soon as the traction on the vessels is relieved this phase passes.

Time and care expended on the full exposure of the vessels are never ill-spent and deliberate and gentle work at this stage is strongly advocated. Blunt dissection with the fingers or with a pair of Mayo scissors is the method of choice. Pedicles vary very much in length. With a favourable one, 1 in. or even 2 in. may with ease be cleared, but many pedicles will not allow this amount of room. Variation is also found in the distribution of the vessels. Sometimes they are bunched together compactly, at other times stray vessels may reach or leave the hilum at some distance from the main bundle, in some instances passing to the iliacs or the lowest part of the aorta or vena cava. The surgeon should be on the alert for such outlying vessels as they are easily injured before being fully exposed and, retracting into the depths of the wound, they may be secured only after a search.

The ligation of the pedicle—This may be undertaken *en masse*, or the vessels may be individually caught in artery forceps and separately divided. The choice is partly dictated by the special conditions obtaining and is partly

a matter of personal preference Marion says ' It is quite useless to tie the vessels separately as it complicates the operation unnecessarily The writer is in the main in agreement though in the presence of a small kidney a long pedicle and a thin patient the individual vessels may be isolated with ease and separately clamped as they may also with a widely spread out pedicle The thin walled vein probably empty owing to traction is easily seen isolated and divided the subsequent exposure of the remaining vessels being thus facilitated A bulky kidney on the other hand fills the wound and obstructs one's view of the pedicle Moreover such a kidney often possesses a short stumpy and perhaps sclerosed pedicle which does not lend itself so well to the individual display of its component elements and therefore to separate ligation

In ligaturing the pedicle *en masse* one may proceed with or without the aid of the renal pedicle clamp Many surgeons employ the clamp but the writer prefers to apply his ligature without its aid His objection to the clamp is a triple one

- 1 It is a large instrument and not easy to apply neatly and securely
- 2 Not infrequently after application it lets the vessels slip with all the dangers and disadvantages inherent in a lost pedicle to be described later
- 3 Though the renal pedicle is more accessible when the kidney has been removed and so at first sight the ligature should be more easily applied in actual fact it is found that as the clamp is opened the vessels retract before the ligature has time to close down on them and a slipped pedicle again results This accident is particularly liable to happen with broad short or indurated pedicles and is a serious one Thomson Walker's description of the method of employing the renal pedicle clamp follows In it I judge one may sense the very difficulties and dangers to which I have alluded

The forceps having been applied the vascular pedicle is cut across on the renal side of the clamp with curved scissors and the kidney removed A double strand of thick catgut (No 4) is placed round the whole pedicle behind the clamp and tied as tightly as possible A second catgut ligature is now placed just central to the first and the first double knot tied The clamp is opened very slowly and at the same time powerful traction is placed on the ligature The first ligature collects the elements of the pedicle into a bunch the clamp often keeping them rigidly spread out at the distal end As the clamp is opened the second ligature closes up the elements of the pedicle still further and exerts full pressure on all the vessels The first ligature may be quite loose when the second has been tied When the clamp is fully opened it is gently removed and the second knot tied on the ligature These manipulations are very carefully and gently carried out without dragging on the clamp and without levering it against the edge of the wound

In tying the pedicle *in continuity* the ligature is usually first passed above the vessels and may be simply thrown over the upper pole of the kidney or may be introduced with a pair of Wells or an aneurysm needle Number two chromic catgut is strong enough and has the virtue over the larger sizes of greater flexibility so that the knot is more easily adjusted The ligature is tied as near the great vessels as convenient so as to leave a sufficient length of vessel on the renal side of the ligature Having obtained a firm knot one end of the catgut is passed round the pedicle a second time overlying the first ligature thus giving additional security The knot may be tied in front of the pedicle or behind as found more convenient the former being usual Before either knot is tied the relationship of the catgut to the pedicle is closely examined both in front and behind to make sure that no extraneous tissue has been included in the ligature an accident which may occur with remarkable ease



The second knot having been tied, the catgut is cut long ( $\frac{1}{2}$  inch) and a pair of artery forceps is clamped on the *margin* of the vascular bundle to the renal side of the ligature the intention being to retain control of the pedicle so as to inspect it after the kidney has been removed (Fig 78 (4)) It will be appreciated that as soon as the strain on the pedicle is released the cut vessels, unless so controlled may retract very deeply into the remote parts of the wound and in some cases may disappear entirely from view into the adipose tissue from which they have been recently dragged Should there have been any failure to secure the vessels they are further hidden by the immediate extravasation of blood and may be most difficult to trace Bleeding in such cases is from multiple points and is copious Great difficulty in identifying all the bleeding points may be experienced with resulting shock and loss of time A satisfactory ligature should be ensured before the kidney is cut away, and the precise instructions given above show the author's conviction that the securing of the vascular pedicle at that stage, once and for all, is fundamental to a safe nephrectomy

A gauze swab is tucked into the wound before the division of the pedicle to catch such blood as will be shed from the kidney (Fig 78 (3)) With scissors the pedicle is now severed, choosing a point as far from the ligature as possible ( $\frac{1}{2}$  in is desirable) and distal, of course, to the artery forceps Where the vascular bundle is short and sclerosed and the ligature has had to be placed very close to the kidney, it has been recommended that a piece of this organ should be cut so as to remain on the pedicle as a safeguard against the slipping of the ligature I can imagine conditions in which such a proceduro would be desirable but have not personally had to resort to it Occasionally a rodundant distended or adherent pelvis gets in the way, but can usually be sponged aside Its injury would be an unfortunate accident in cases of sepsis, tuberculous disease or new growth

The kidney having been removed the pack is withdrawn and a glance at the pedicle shows that it is secure The artery forceps which are still on the margin of the stump of the renal pedicle are therefore gently unclamped and any clot is sponged from the recesses of the kidney bed

It is recommended by some authors that the perirenal fat should be removed on account of its poor viability The writer is convinced that this is unnecessary and that the fat gives no trouble in the after-treatment Moreover, its removal may cause small points of bleeding and attention to these disturbs the wound when it is best left quiet Fat removal is particularly advocated following nephrectomy for renal tuberculosis and neoplasm as these may extend into it It is probably good practice in the latter disease, but in the former the sole factor governing wound healing is the freedom from operative contamination of the wound by tuberculous pus If this can be avoided the healing will be satisfactory and there is no need to interfere with the perinephric fat

### DIFFICULTIES

Operations on good subjects whose kidneys show but little pathological adhesion or gross increase in size are not particularly difficult, but enlargement and adhesion may reach almost any proportions and may produce conditions of great difficulty

The enlarged kidney may be solid or fluid If solid it is essential to have adequate room through which to deliver it, but the fluid, hydronephrotic, or pyonephrotic organ can be reduced in size by emptying it of its contents This, however, is not always advisable as, for instance, when the infection

is tuberculous or a hydronephrosis is caused by a growth of the pelvis. Nevertheless in the majority of instances fluid collections may be evacuated without danger by trocar and cannula or by a pump if large. When a thin walled non adherent hydronephrosis has been emptied the collapsed sac is as a rule quite easily shelled from its bed through an incision of the usual size. On one occasion the writer withdrew  $1\frac{3}{4}$  gals from such a sac and as a further quantity was lost the total cannot have fallen far short of 2 gals. The pelvis extended deep into the true bony pelvis and to the opposite anterior superior iliac spine. Yet it shelled out safely through the ordinary incision above described.

A hole made in the kidney for purposes of evacuating its contents is not easily closed as the parenchyma is friable and will hold neither a clamp nor a stitch. Further leakage from the opening is almost inevitable during the manipulations. For this reason the first evacuation should be as thorough as possible. A hole in the pelvis is more easily managed.

The conditions are very different when a solid growth or a fluid one which for some reason should not be evacuated requires removal. Here additional room must be obtained and the surgeon has the choice of going forwards to wards the middle line of the abdomen or backwards and upwards by excising the last costal element. Let him realize that the renal vascular pedicle acquires its attachment to the great vessels at a point much higher than the lower costal margin and that the upper pole of the kidney is less accessible than the lower. The excision of the last rib brings him nearer to these points and as a rule is more helpful than the anterior extension which however may be employed additionally with advantage. The loss of a last rib on the other hand renders some weakening of this area inevitable and the intercostal muscles which must perforce be used for the subsequent closure of the wound offer poor material for this purpose. I myself therefore though not hesitating to excise a rib when I consider it desirable reserve this procedure for cases where I regard it as genuinely necessary and do not employ it merely to facilitate the operation.

To expose the last rib the incision is curved upwards over the outer border of the erector spinae muscle and the superficial tissues on the upper side of the wound are reflected as a flap. Seeing that the periosteum over this rib is more intimately bound down than that over most of the other ribs it is well to make a double incision skirting the superior and inferior margins so as to gain immediate access to the edges of the bone. Numerous muscular attachments are divided with the point of the scalpel or are torn through with the periosteal elevator. With ordinary care it is easy to raise the bone from the anterior layer of periosteum (a moderately strong structure) leaving the latter quite intact. The tip of the rib when free is raised firmly with bone forceps so as to expose the attached end of the bone and to facilitate its exposure far back. As much as possible of the rib must be removed if the full value of this procedure is to be gained. It is well to trim off the cut end of the rib neatly as it is often left sharp and spinous and is very liable to tear the rubber glove or even the finger.

The last rib varies greatly in length. When long its removal provides most acceptable additional space and makes all the difference not only in the approach to the upper pole and pedicle but also in the general accessibility of the kidney as a whole whilst many organs which refuse to emerge through the space between the costal margin and the iliac crest can be freely delivered after the rib has been excised.

If the rib is a small one its removal is less helpful and it is justifiable occasion ally to take the eleventh rib also should the circumstances appear to require

it The experienced examiner of renal X-ray films is constantly on the watch for accessory ribs and also for small and absent twelfth ribs, the latter being quite common. An accessory rib will therefore have been noted pre-operatively and may be removed together with the last rib proper.

After the removal of such rib or ribs gentle digital traction will be adequate to ensure that the soft tissues yield the maximum amount of space. Cutting at this stage should be proscribed as thereby the pleura will be endangered. The pleura is protected by the still intact diaphragm below, and the intercostals externally. With the most ordinary care it should not suffer injury and the writer can assert that certainly within the last fifteen years, no accident has befallen it in his practice.

In the forward direction some surgeons continue the line of the original incision downwards towards the external abdominal ring, but this takes one away from the principal operative area. This extension may be used when it is desired to do a nephro ureterectomy though I myself prefer to employ a separate incision for the removal of the ureter as it tends to leave a stronger abdominal wall and a better cosmetic result. For a nephrectomy, superior access is afforded if the incision is produced in a transverse direction towards the umbilicus. A variation of this is an incision extending to the linea semilunaris to which is added a vertical incision along this line. This latter addition is regarded by myself as unnecessarily traumatic and as not providing the room where it is most needed.

**Perinephric adhesion**—Many kidneys operated upon present some amount of perinephric adhesion but the degree is extremely variable. Usually inflammatory in origin it may also occur with renal growths and is invariably present at repeat operations on the kidney. Mild adhesions increase the operative difficulties to an extent which is trifling, but in bad cases the adhesions may be  $\frac{1}{2}$  in or more in thickness, rock like in consistency, and completely obliterate all anatomical landmarks. Nevertheless, even though the operation may prove formidable and be prolonged it is most unusual for an experienced surgeon to fail in eradicating an adherent kidney. Successful nephrectomies in these circumstances provide some of the most dramatic of surgical cures.

In undertaking such a case it is usually wise to follow the line of a previous operation, if any, as this practice, in addition to avoiding multiple scars finds an avascular line of approach and generally leads directly to the kidney—a point of some importance. An adequate exposure is fundamental and removal of a rib may with benefit be done immediately, though I prefer not to resort to it until I have convinced myself by further observation that such a sacrifice is really desirable. Stripping with the finger and blunt dissection are employed as far as possible, but will prove insufficient in the more difficult cases. They will be supplemented by snipping with the scissors or scalpel. Advance will be made now here, now there, according as the scar yields. It is only in the worst cases that the scar is uniformly dense and some section can usually be discovered where progress is relatively easy. An early attempt should be made to determine the outlines of the kidney proper, perhaps by working into the scar itself, and the dissection should then keep as close to the organ as feasible, leaving the scar behind on surrounding structures. A certain amount of force has to be exerted in the majority of cases and it is discretion and skill in the application of this which is the foundation of success in this type of work. Force may be used in some areas with relative safety, whilst in others it is fraught with risk. Thus posteriorly the work can proceed freely because even should the muscles which constitute the kidney's posterior relations be encroached upon no great disability would ensue, the same is

true at the upper pole till the region of the suprarenal is approached when the surgeon must attempt to follow the renal boundary accurately. At the lower pole there are no important relationships posteriorly and the dissection can usually be fairly forceful until the line of the ureter is encountered. The anterior relationships are in a different category and here the dissection proceeds circum-spectly till the anterior surface of the kidney itself is defined—not always an easy matter—and the peritoneum has been safely reflected. An opening into the peritoneal cavity is neither an infrequent accident nor of much consequence so long as it is moderate in size and the gut is not involved—a very rare accident

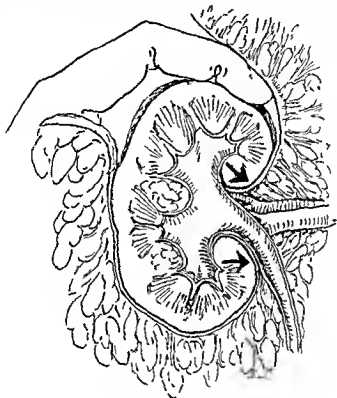


FIG. 79

Subcapsular nephrectomy. Finger passes between parenchyma and capsule which is densely adherent externally. Arrows indicate that capsule must be divided to expose pedicle for ligation.

The repair of the peritoneum is best deferred to the end of the operation, the hole in the meantime being protected by gauze. If the damage is done during the separation of the upper pole it may occur high under the ribs and in this situation difficulty will sometimes be experienced in suturing it as it is a thin, tense membrane.

Finally the pedicle is approached. It may prove to be less affected and troublesome than other obstacles which have already been overcome and will then be dealt with in the usual manner. Conversely it may be just as densely sclero-ed as the regions already encountered, and scar in this situation may still anchor the kidney to its bed and prevent its elevation on to the loin. The kidney's bulk therefore gets in the way of the access to the pedicle. In clearing the pedicle one is liable to imagine that it has been reached before

this is actually the case. It is most desirable to expose and see the actual vessels. Dissection proceeds patiently but determinedly, reflecting scar both anteriorly and posteriorly till this is accomplished. It is very unwise to put a ligature round a mass of scar as it will neither control the vessels nor hold its own position satisfactorily. Should the surgeon in approaching a pedicle of this sort injure an outlying vessel he will find that it presents at least this advantage—being anchored by scar it does not retract out of view and so, as a rule, can easily be secured.

Sometimes the adhesion is so dense that it is virtually impossible to separate it from the kidney capsule. The surgeon may then have recourse to a *subcapsular nephrectomy*. The finger readily finds a line of cleavage between the capsule and the parenchyma and the latter is quickly separated as far as the pedicle. Two difficulties are now encountered (1) the kidney is not mobilized and the work is therefore carried out in a deep recess, (2) the surgeon is on the opposite side of the greatly thickened capsule from the vascular pedicle (Fig. 79) and must now expose the latter by dissection as it is unsafe to transfix it blindly, and apart from transfixion a ligature will not hold. An extracapsular nephrectomy is to be preferred when possible, but when perinephric adhesion is excessive the subcapsular method can be usefully employed. It is not permissible in tuberculous disease nor when removing a renal growth.

Other causes of difficulty in dealing with the renal pedicle are glands, especially malignant glands surrounding the vascular pedicle, and hypernephromatous tissue within the vein. The discovery of glandular involvement round the vessels may come late in the operation when the kidney is almost ready for removal. It is generally unwise to attempt the removal of such glands, but their presence may make for some difficulty in applying a ligature.

The well known habit of a hypernephromatous growth of projecting itself into the vein will cause the operator in such cases to examine that structure before tying it. Sometimes it is found packed with growth and on such occasions I have first dealt with the remainder of the vessels by individual ligature. The vein is by this means isolated and with a scalpel it is divided as close as possible to the kidney, a ring encircling it in a transverse direction. No hæmorrhage of note need be feared. As the kidney is withdrawn a tongue of hypernephromatous material follows it. On one notable occasion I withdrew 10 in. of such tissue, most of which occupied the vena cava and extended upwards towards the chest. There was no hæmorrhage and no apparent danger of air embolism. It is doubtful if this procedure would have been possible if I had been operating by the abdominal route.

#### CLOSURE OF THE WOUND

The bed from which the kidney has been enucleated usually exudes a quantity of sanguineous serum for the first twenty-four or forty-eight hours and it is well by means of a tube to provide an exit for this, as also for urine which may escape from the kidney in certain circumstances. The closure of the wound is carried out by a double layer of sutures. The first is a continuous stitch of number one catgut which draws together the edges of the transversalis muscle and aponeurosis (Fig. 78 (5)). In poorly developed subjects the transversalis fibres split as the stitch is drawn taut and the needle in such circumstances may with advantage be made to include in its bite a little of the adjacent internal oblique. A sharp look-out must be kept for the last dorsal nerve which sometimes retains its position along the upper or lower margin of this muscle, and it should be excluded from the stitch.

The second suture line is an interrupted one. Number two or three chromicized catgut is used in 10 in. lengths which take a good bite of both the oblique muscles (Fig. 78 (G and H)). Towards the front of the wound it will be found that the internal oblique has retracted from view under cover of the external and care is called for here to ensure that it is not overlooked. Each end of each suture is caught with a pair of small Wells forceps and they are laid out across the wound in an orderly series. When all sutures are in position the bridge is let down or the table is straightened out according to the type of elevation being employed. Then the assistant lifting the ends of the various sutures by means of the appropriate forceps presents each pair to the surgeon in the correct order to be tied. When a rib has been excised the postero-superior part of the wound offers poor material for suture.

In stout patients the ample subcutaneous fat of this region should be drawn lightly together as otherwise dead space will allow accumulation of fluid and so interfere with primary union. Interrupted skin stitches complete the operation.

### TRANSABDOMINAL NEPHRECTOMY

Situated as it is behind the posterior parietal peritoneum the kidney is in the vast majority of cases best approached by the lumbar route. Occasionally the abdominal route may be chosen as for instance when an intraperitoneal lesion requires simultaneous attention. But the transabdominal route must only be employed when it has been decided beforehand to do a nephrectomy and usually for a neoplasm. It is quite unsuitable for any procedure which opens the urinary passages as for instance the removal of a stone and also for tuberculous cases. It is claimed that this approach gives good access to very large kidneys and that the pedicle is secured early thus preventing dissemination of new growth by operative manipulation. A really large kidney however will by its very size defeat this intention.

The abdomen is opened through a paramedian incision which may if necessary be extended to the whole length of the abdomen. Young recommends the addition of a transverse incision passing outwards for several inches on a level with the lowest point of the ribs. When the peritoneum has been opened a search for secondaries is made. In their absence the small gut is packed aside but is in some cases especially in stout subjects a source of difficulty as coils persistently overflow the operative field. The ascending or descending colon is identified and drawn inwards. The posterior layer of the parietal peritoneum is incised outside the colon and is raised from the surface of the kidney. When adherent it may be necessary to leave some of the peritoneum attached to the kidney. The renal vessels and ureter are exposed ligatured and divided and the kidney is dissected free and removed. Dense adhesions posteriorly sometimes make this difficult. The kidney bed is drained through a stab incision in the loin and the wound in the posterior layer of peritoneum is carefully closed.

J. B. MACALPINE

## CHAPTER XIV

### SURGICAL ANATOMY AND PHYSIOLOGY OF THE URETERS

#### DEVELOPMENT

THE ureter appears as a bud given off from the primary excretory (Wolffian) duct at the twenty sixth day of intra uterine life when the embryo is about five millimetres in length. The ureteric bud develops cranially to become the primitive renal pelvis at its upper expanded extremity where it comes into relation with the metanephros. The caudal portions of the primary excretory ducts are absorbed into the urogenital sinus to form the vesical trigone. During this process the ureter requires a distal terminal opening into the bladder when the embryo is approximately 11 or 12 mm long. Thus in the development of the bladder the ureteric orifices are already above and lateral to those of the primary excretory (ejaculatory) ducts.

#### ANATOMY

The ureter is a relatively thick muscular tube which is characteristically firm on palpation. It has an average length of 30 cm and measures less than 1 cm in diameter. The ureter extends from the renal pelvis above to the ureterovesical opening below. The abdominal and pelvic portions are equal in length and as the ureters descend on the psoas muscle they converge slightly so that as they enter the pelvis where they cross the iliac vessels they are about 6 cm apart. Within the pelvis the ureter pursues an arched course with its convexity posteriorly and laterally and it enters the bladder obliquely from a postero lateral angle at the base of the trigone.

**Relations—ABDOMINAL PORTION—Anterior—**The anterior layer of the perirenal fascia (Gerota) soon fades away in the retroperitoneal tissue of the iliac fossa and the ureter comes into intimate contact with the posterior parietal peritoneum throughout the greater part of its abdominal and all its pelvic course. As the peritoneum is stripped from the posterior abdominal wall the ureter is mobilized with it in the thin extraperitoneal fascia. The right ureter is crossed by the right colic ileocolic and testicular or ovarian vessels and the left ureter by the testicular or ovarian artery and left colic vessels.

**Posterior—**Both ureters have similar posterior relations. The ureter descends on the psoas muscle inclining slightly medially. It crosses the genito femoral nerve and the external iliac artery at its origin.

**Medial—**The vena cava lies medial to the right ureter. The left testicular or ovarian vein is medial to the left ureter and lies between it and the inferior mesenteric vein.

**PELVIC PORTION—**The ureter runs backwards and downwards in the pelvis till it reaches the level of the ischial spine where it turns downwards and inwards to the bladder. It can be seen shining through the parietal peritoneum which lies antero medially.

**In the female** on the side wall of the pelvis the internal iliac artery is above and behind the ureter while laterally the psoas and obturator internus muscles

are separated from the ureter by the external iliac vein, obturator nerve, obturator, vaginal and uterine vessels in that order from above downwards. On the pelvic floor as the ureter turns forwards from the ischial spine it lies on the levator ani close to the lateral fornix of the vagina, it lies below the base of the broad ligament and is crossed by the uterine vessels as they pass medially, and the ureter turns forwards to enter the bladder.

*In the male* on the side wall of the pelvis the internal iliac artery lies above and behind the ureter, while laterally the psoas and obturator internus muscles are separated from the ureter by the external iliac vein, obturator nerve and the obturator and inferior vesical vessels. On the pelvic floor as it turns forwards on the levator ani the ureter is crossed by the vas deferens close to the bladder, which it enters, slightly overlapped by the upper border of the seminal vesicle. The terminal portions of the ureters are surrounded by a plexus of veins and lie 3 to 5 cm. apart as they pierce the muscular wall of the bladder. The course of the intramural portion of the ureter is oblique so that the ureteric orifices are not more than 2 to 3 cm. apart on the ureteric ridge at the base of the trigone.

**Blood supply**—The ureter has a free blood supply from the main vessels adjacent to it throughout its course in the abdomen and pelvis. Thus the renal, testicular or ovarian and coeliac arteries supply the abdominal part of the ureter, and the vesical, middle-rectal and uterine arteries the pelvic portion. The ureteric vessels through their many branches intercommunicate freely and form an anastomosis (a) on the adventitial coat or sheath of the ureter, and (b) on the submucous or inner coat. These plexuses also intercommunicate freely by means of perforating tributaries through the muscular coats. Thus it is possible, though inadvisable, to strip the adventitia from considerable sections of the ureter without consequent necrosis from interference with blood supply. The venous return is by the many ureteric veins to the vesical, uterine, lumbar and renal veins. At the lower end of the ureter the venous plexus in the sheath is very markedly developed and, when injured, there may be a troublesome amount of bleeding which obscures the operation field.

**Lymphatics**—The lymphatics of the ureter accompany its vessels and pass medially from the ureter to the corresponding groups of glands. These are situated in relation to the internal external and common iliac arteries, the aorta and vena cava, and the testicular or ovarian and renal arteries. The lymphatics arise in the submucosal and adventitial coats of the ureteric wall. Like the vascular plexus, the lymphatic plexus is continuous throughout the length of the ureter. From the plexus and draining it, however, lymphatic channels pass medially from each segment to the corresponding glands which accompany the vessels. These may be grouped as iliac, lumbar and renal lymph nodes. The animal experiments of Mackenzie and Wallace (1935) have demonstrated that dye particles drain medially and in a segmental manner from the ureteral lymphatics to the lymph glands accompanying the vessels. They failed to find evidence of an ascending or direct route of lymphatic drainage from the lower ureter to the kidney. Investigating along similar lines, Parker (1940) found that although the lymph collectors of the ureter passed upwards and downwards for variable distances they eventually left the duct for the regional lymph nodes.

**Nerves**—Mitchell (1935) has described three main groups of ureteric nerves: (1) A superior group from the lower fibres of the renal plexus or from the inter-mesenteric nerves. (2) An intermediate group from the superior hypogastric (presacral) plexus or from the upper end of the hypogastric nerve. (3) An



inferior group from the lower end of the hypogastric nerve and the upper part of the inferior hypogastric plexus

Both for interpretation of symptomatology and for the purpose of surgical denervation of the ureter it should be noted that intercommunications have been described (a) between the superior and intermediate ureteric nerves and the testicular or ovarian nerves and (b) between the intermediate and inferior ureteric nerves and the nerves of supply to the vas deferens the seminal vesicle and the epididymis or the ovary and the uterine tube (Mitchell 1938). It is noteworthy that Lenneth's (1931) clinical observations showed that stimulation of the hypogastric nerve is followed by contraction of the corresponding ureteric orifice and that a hypogastric neurectomy is an effective procedure in the treatment of megaloureter

### HISTOLOGICAL

The ureter has three coats (1) the adventitia which is an outer fibrous sheath containing the adventitial vascular plexus (2) a middle coat of three layers of involuntary muscle. The outer and inner layers consist of longitudinal fibres and the middle layer is of circular muscle and (3) the inner coat is made up of a lining of stratified transitional epithelium with a fibro elastic submucosa which like the sheath contains a vascular plexus. The elastic fibres of the inner coat throw the mucous lining into longitudinal folds and give the lumen of the ureter a characteristically star shaped appearance on cross section. In the lower portion of the ureter longitudinal muscle fibres are present in the sheath. E. A. Schaffer (1929) found an increased proportion of connective tissue among the muscle bundles of the upper two thirds of the ureter whereas in the lowest third the connective tissue is relatively scanty and the musculature predominates. The outer longitudinal layer of muscle consists of coarser fibres at this level and the longitudinal layer is continued to fuse with that of the bladder wall (Waldeyer's sheath).

For clinical purposes the ureter is often divided into uppermost middle and lowest thirds but anatomically points of narrowing are constantly present at three levels (1) the ureteropelvic junction (2) the crossing of the iliac artery and (3) the intramural portion at the entrance to the bladder. In the female a fourth point of narrowing is found at the base of the broad ligament. Between these points the ureter is of wider calibre and radiographic demonstration of these so called spindles in the normal ureter has led to the adoption of the terms (1) the abdominal spindle (2) the pelvic spindle and (3) the lower pelvic spindle in the female when describing the ureter.

At the pelvic brim the ureters cross the iliac vessels obliquely where the common iliac artery divides into internal and external divisions. At this point there is a difference in the course of the ureter on the two sides owing to the difference in the course followed by the two iliac vessels. The right common iliac artery crosses the vertebral column from left to right and therefore lies more anteriorly than the left. The right ureter has to cross over the right common iliac vessels almost at a right angle to gain the pelvis. It accordingly has a more exposed course than the left which is partly protected by the promontory of the sacrum and in addition by the sigmoid colon and its mesentery which lie anterior to it.

### PHYSIOLOGY

Trattner (1932) has studied the movements of the ureter in dogs. He describes the peristaltic waves as (a) longitudinal contractions which shorten

the ureter and (b) a circular contraction which momentarily obliterates the lumen as the wave advances. Peristaltic activity as far as the longitudinal contraction is concerned rapidly involves the entire ureter whereas the circular component is more segmental. The amplitude of a wave of contraction varies from 2 or 3 cm. to 8 or 10 cm. water pressure. The rate of peristaltic action varies from one contraction every two or three minutes to one every five or six seconds. The rhythm depends on the rate of secretion of urine so that a series of contractions may be noted with regular or irregular variations in their time of occurrence. The uppermost third of the ureter is more excitable than the lower portions and it is believed that the renal pelvis acts as pacemaker.

Although peristalsis is normally downwards a reversed peristaltic activity may be excited. This is shown constantly by the ease with which ascending ureterography and pyelography may be carried out when sodium iodide is injected through a ureteric catheter whose tip lies just within the lumen of the lower ureter. Vigorous antiperistaltic movements can be elicited by pinching the ureter. This can be seen particularly well when there is a partial obstruction which has led to hypertrophy of the muscle. In the presence of complete ureteric obstruction both spontaneous peristaltic activity and the response to stimuli are greatly reduced. The withdrawal of retained fluid leads to the return of peristalsis which may be vigorous or even reversed.

Any obstructive factor which can cause over distension of the ureter would appear to abolish peristaltic movement and thus lead to stasis whereas an abundant downward flow of urine makes the most effective ureteric stimulant. Pyeloscopy and intravenous urography have provided important contributions to the study of the nature of ureteric activity. Thus it has been proved that only a part of the ureter is filled by the opaque urinary medium at any one time.

Cumming (1930) by serial photography showed that apparent narrowing of the ureter was really the upper or lower limit of a peristaltic wave. The characteristic shadow of the filled portion of the ureter is called the ureteric spindle and in a normal ureterogram the ureteric spindle is divided into two parts abdominal and pelvic between the normal sites of narrowing of the ureter at the ureteropelvic junction, the crossing of the iliac vessels and the intramural or juxta vesical levels. The interpretation of ureterograms may be difficult in retrograde pyelography when the presence of an indwelling ureteric catheter or over distension by opaque medium leads to disturbance in normal peristaltic activity and in particular to spasm. Similarly the interpretation of intravenous urograms may be rendered just as difficult when uroselectan is rapidly swept down the ureter by a normal active peristalsis and accordingly incomplete ureterograms are obtained.

Compression of the ureter by mechanically obstructing it may improve visualization but this procedure by its very nature upsets physiological conditions. Baird (1935) has carried out manometric observations on the tone of the ureter in pregnancy. He noted that the tone of the normal primigravid ureter reached in its upper segment 30 cm. of water pressure and in its lower segment 40 cm. Trattner (1939) had made original observations on ureteric tone using an electrical drop recorder. He found that the intra ureteral pressure during peristalsis varied between 3 and 18 cm. of water and ureteric contractions could be induced by the injection through the catheter of a few cubic centimetres of saline. The response was measured by noting the frequency and amplitude of the ureteric contractions including any tendency to spasm.

**The ureters in pregnancy**—The ureter in pregnancy has been shown to undergo changes which are characteristic. During the last six months of pregnancy there is a progressive ureteric atony accompanied by dilatation

and often tortuosity and kinking, which lead to urinary stasis and hydronephrosis (Figs 80 and 81). Anatomically the lower end of the ureter is found to have undergone hypertrophy. It is at this level that the outer longitudinal



FIG 80  
Hydroureter of pregnancy with calculi  
in renal pelvis



FIG 81  
Hydroureter of pregnancy The fetus  
is shown



FIG 82  
Hydroureter of pregnancy

muscle fibres of the ureteric wall are normally coarser in structure, and there is proportionately less connective tissue in the sheath. During pregnancy there is a hyperplasia of the musculature of the sheath at the lower end of the ureter, which becomes greatly thickened and semi-rigid. Several views have been expressed as to the aetiology of these changes especially when the lack of tone, the dilatation and the hypertrophy have been shown to disappear completely at the termination of the pregnancy.

F J Browne (1942) believes that the atony is due to the amount of active progesterin in the circulation during pregnancy. The atony and dilatation are most marked on the right side. They are present only above the pelvic brim, below which, on the right side particularly, the ureter is thicker and more rigid than normal. Hofbauer (1928)

who described these changes, considered that the rigidity of the lowermost segment of the ureter had led to obstruction and stasis in the upper two-thirds. Baird (1935), however, holds the view that the thickening of the lower segment is protective, in order to prevent undue pressure on the ureter from the pregnant uterus, which might otherwise cause actual obstruction of the ureter during the latest weeks of pregnancy. It has been noted that the right ureter is exposed

to a greater pressure in the pelvis than the left on account of a difference in the course of the two iliac arteries (Baird). On the left side the ureter is more protected as it lies behind the mesocolon. On the right side the ureter lies anterior to the common iliac artery which has crossed the vertebral column and so occupies a more forward position than its neighbour. These anatomical factors may have some relation to the greater frequency of right sided hydro-ureter and hydronephrosis in pregnancy. In addition the pregnant uterus inclines slightly to the right.

The dilatation is of the greatest size in the first pregnancy and tends to decrease in each succeeding one.

It has been shown that the dilatation of the ureter runs parallel with the excretion of oestrogen and corpus luteum hormone. These substances are excreted progressively from the third month onwards from which time the placenta takes over the production of them. This last fact has been made clear by the experimental work of Van Wageningen and Jenkins (1939). Working with ten Rhesus monkeys they followed the changes in the ureters by urography through thirty seven successive pregnancies. In one animal hydro-ureter appeared almost three months after the foetus had been removed the placenta remaining undisturbed throughout.

MacLean and Denning (1943) have shown that the period of greatest dilatation of the ureters is also the period when renal infection has its greatest incidence.

**PATHOLOGY**—*Status* of the ureter and the sequelæ of dilatation. Kinking and hydronephrosis are important contributory factors to the 1 per cent incidence of pyelitis as a complication of pregnancy (Browne). Infection of the upper urinary tract in association with hydroureter is often very resistant to treatment and focal infection of the ureter may be followed by fibrosis and stricture, an organic lesion which persists when the pregnancy is over and the ureter should return to normal shape and function (Fig. 82). The ureteric stricture of multiparae is due to repeated dilatations of the ureter accompanied by infection in successive pregnancies. The stricture is found just below the pelvic brim and may give rise to a gross hydronephrosis and hydroureter above. Interference with the venous plexus as a result of the dilatation and stricture of the ureter has led to a local varix in its wall. Middleton (1928) has pointed out that such varices may be the source of bleeding in some cases of so called essential hæmaturia.

**TREATMENT**—Simple hydroureter of pregnancy is so constant and usually symptom free that no treatment is required. But when pyelitis of pregnancy is present treatment is certainly necessary (see p. 742). Hæmaturia of pregnancy of the essential type responds well to the removal of residual urine by an indwelling ureteric catheter.

## PHARMACOLOGY

Morphine causes an increase in the tonicity of the ureter but combinations of the total opium alkaloids which contain papaverine and narcotine inhibit ureteric contractions and relax its tone. Drugs of the cholin group cause increased peristaltic activity through their action on the parasympathetic innervation whereas atropine preparations depress the parasympathetic fibres and cause relaxation. Morphine and atropine together have been used constantly for their central analgesic and local spasmolytic effects in ureteric colic. This standard combination has the disadvantage of producing a considerable narcotic effect when repeated doses are required. Many drugs have

been used in the treatment of ureteric stone with a view to facilitating descent by more vigorous peristalsis or by relieving spasm during endoscopic instrumentation. Pethidine hydrochloride has spasmolytic properties like the atropine group. It antagonizes acetylcholine and depresses the tone of smooth muscle. Clinically pethidine has proved of value in the treatment of renal colic because of its central analgesic effects without accompanying narcosis (Bramwood 1943). Avertin rectally has been used preparatory to cystoscopic examinations and manipulations on account of its spasmolytic effects. Jarman and Scott (1937) have injected a freshly prepared 2 per cent solution of avertin to the ureter prior to the withdrawal of twisted ureteric catheters in the treatment of calculus. Pancreatic tissue (insulin free) extracts have been employed in similar circumstances for their marked dilator effect on plain muscle (Lazarus 1940). Papaverine hypodermically accompanied by the intra-ureteric injection of a solution of cocaine should together exert the maximum dilator effect on the ureteric musculature, with the additional advantage of vasoconstriction. Prostigmin, as a vagotonic agent without the more widespread action of physostigmin, has been employed to increase peristaltic activity of the ureter in atonic dilatation.

### EXAMINATION

**Symptomatology**—The characteristic symptom from disturbance of ureteric function is a colicky pain which radiates from loin to groin. The pain in the loin is accounted for by the distension of the renal pelvis and capsule which must always accompany an obstructive lesion of the ureter. The waves of excruciating pain which radiate downwards are due to irregular and violent peristaltic contractions of the ureteric tube, but though the colic is agonizing while it lasts and, as a rule, works up to a climax, the contractions may be intermittent, or give rise to no more than recurring twinges. The renal-distension pain is constantly present, and of a sickening intensity during the height of the colic. It has a tendency to persist as an ache or, more certainly, as a sensation of discomfort in the loin while the causal lesion remains. Sometimes the patient can localize on the abdominal wall the segment of the ureter affected; he may describe the descent of a ureteric calculus and offer an opinion as to the level affected by the stone. Such a localization must be possible from a persistent spasm of the ureteric musculature, which, owing to the segmental innervation of the ureter, gives rise to a referred pain.

Lesions of the juxtavesical portion of the ureter may lead to painful defecation or ejaculation and lesions of the intramural part or its vesical opening to disturbance with micturition. The segmental innervation of the ureter links up that organ with the renal plexus and intermesenteric nerves, the testicular or ovarian nerves and the nerves to the vas deferens and seminal vesicle. These connections explain the nausea, vomiting and abdominal tympanites which may be very misleading in a patient with ureteric colic who presents acute abdominal symptoms. The frequency with which appendicular and a right ureteric colic may be confused is well known. Similarly a left ureteric colic may simulate intestinal obstruction.

The association of genital pain with ureteric lesions is very characteristic. This is not unexpected when the developmental relations of the ureteric bud to the Wolffian body and duct are taken into consideration. Infections of the ureter which are exudative and extend to the periureteric tissues lead to irritation of the retroperitoneal nerves and cause localized tenderness and rigidity of the abdominal wall in common with all intra-abdominal inflam-

mations Such conditions as tumour of the ureter or tuberculosis of the ureter often associated with gross thickening of the tube are not painful when there is no obstruction to the upper urinary tract

**Inspection**—Thomson Walker (1936) reported the case of a child with gross ureteric distension which was visible on the abdominal wall

**Palpation**—The course of the abdominal ureter may be traced from a point 4 cm from the median line opposite the second lumbar vertebra to a point 3 cm from the median line on a line joining the anterior superior spines of the ilium The right ureter lies a little to the inner side of the base of the appendix The ureter may be compressed through the abdominal wall and the contractions excited used to assist in the localization of calculus Occasionally in a co-operative patient deep palpation may demonstrate a thickened ureter by rolling it outwards under the fingers

**ON RECTAL EXAMINATION** in the male preferably using the knee elbow position the ureter may be palpated by inserting the finger high up to the lateral pelvic wall and then with a downwards and inwards sweep bringing the pulp of the finger to bear from the bladder base and seminal vesicle to the base of the prostate In the female the ureter may be palpated through the antero-lateral walls of the vagina at the junction of its upper and middle thirds Although the ureter has normally a firm and cord like consistency a considerable degree of thickening is necessary to render it palpable from below

**Radiography**—On an X-ray plate the course of the ureter may be visualized as it passes downwards on the psoas muscle from the level of the second lumbar vertebra close to the tips of the transverse processes of the vertebrae and inclines medially to cross the centre of the ala of the sacrum In the pelvis the line passes slightly outwards to pass just internal to the lower margin of the sacro-iliac joint It then follows the pelvic wall with an outward convexity till it turns medially to the bladder opposite the ischial spine The radiograph should be sufficiently soft to outline the outer border of the psoas muscle Occasionally the soft tissue shadow of a greatly distended or thickened ureter may be recognized Ureteric calculi are to be distinguished from pills bismuth enteroliths calcareous glands and phleboliths An aperient such as a liquorice powder which does not lead to gaseous accumulation in the colon makes an excellent pre radiographic preparation but when gaseous distension interferes with good radiography pituitrin may be administered with effect

**Cystoscopy**—The appearance of the ureteric orifices on the interureteric ridge of the trigone of the bladder is of fundamental importance in a routine cystoscopic examination (see p 254) The ureteric orifice may be described under three headings (A) position (B) number and (C) appearance

(A) **POSITION**—Normally the ureteric orifice presents a slit like opening at either extremity of the interureteric ridge at the base of the vesical trigone Under observation the orifice may be seen to retract before evacuating a clear jet of urine into the cystoscopic medium With a clear medium and adequate illumination the smallest ureteric orifice should be capable of identification in its usual position No sign of a ureteric orifice under such conditions is evidence which points strongly to congenital absence of the ureter and the kidney on that side or an abnormal implantation of the ureter Confirmation may be arrived at by chromocystoscopy after the intravenous injection of indigo carmine when the entire bladder mucosa posterior urethra or vaginal vault may be inspected for the missing ureteric orifice The observations following intravenous urography provide an important contribution to the evidence for or against the diagnosis of the absence of a functioning kidney and ureter

(B) NUMBER—A double ureter with two ureteric orifices is present in 3 to 5 per cent of examinations. The lower opening is that of the ureter leading to the upper and smaller segment of the renal pelvis. The openings usually lie close to one another in line on the ridge.

(C) APPEARANCE—Contracture, retraction and dilatation may be noted as the actual condition of the orifice under inspection. In addition there may be alterations in the vesical mucosa immediately adjacent to the orifice such as congestion, œdema or ulceration. The termination of the ureter may balloon into the vesical cavity in ureterocele or it may be retracted upwards and outwards from a chronic ureteritis such as that due to tuberculosis. A small calculus may be present in the orifice or its lips may be lacerated from trauma due to the recent passage of a stone.

The nature and time of the appearance of the efflux require a little patience for adequate visualization. The ureteric orifice is drawn up before the oncoming peristaltic wave which leads to a discharge from the ureter. Since the bladder has been filled with a medium ureteric contractions may have been damped down for the period of examination unless diuresis has been procured by pre cystoscopic preparation.

The smoke like puff of a bloodstained efflux is characteristic and of the greatest value in the investigation of cases of hæmaturia. In pyonephrosis the discharge from the ureter is typically semi solid like that expressed from a tube of tooth paste. Worm like clots may be ejected when there has been a hæmorrhage from a tumour of the kidney or ureter. Finally the time of appearance, the rhythm of ejection and the concentration of dye in the efflux may provide valuable information as to the state of the kidney above when chromocystoscopy is carried out after the intravenous injection of a saturated solution of indigo carmine.

URETERIC CATHETERIZATION is of signal importance in the investigation of the urinary tract. The passage of the catheter not only demonstrates the permeability of the ureter but provides the means of segregating the urine excreted by the two kidneys. The specimens so obtained may be investigated chemically for function, bacteriologically for organisms and cytologically for cells and crystals. Three types of ureteric catheter are usually employed: (1) olive tipped, (2) flute ended and (3) bulb catheters. They are of gum elastic finish, radio opaque and so marked in rings that the number of centimetres of catheter passed can readily be read by the observer during cystoscopy.

Ureteric catheters should be kept in a cool and dry storage cupboard so that deterioration by softening may be avoided. In the warm urological theatre prior to use the catheters may be laid out in an antiseptic lotion containing ice blocks. In this way the cystoscopist comes to rely on the natural rigidity of the ureteric catheter for its passage through the ureteric opening and he will avoid the employment of a stilette.

An efficient catheterization of the ureter is undertaken without unnecessary trauma and any risk of perforation of the ureter by the impaction of the tip in a mucous fold. A catheter which is too soft offers no purchase and conversely too rigid a catheter will not conform to the curves of the ureter in its passage upwards. Pain, ureteric spasm, hæmorrhage or injury may be caused by too vigorous catheterization. On the other hand the choice of a suitable catheter and rotatory movements during its passage may enable the cystoscopist to catheterize a highly irritable ureter. The simultaneous injection of sterile water during instrumentation may lead to success in a difficult case when there is ureteric spasm.

Olivary tipped catheters are of greatest value when there is contracture or spasm of the ureteric orifice but generally speaking the flate ended catheter is the most serviceable type in routine service. Bulb catheters have their use when it is important to collect the total urine excreted in a given time by the kidney during functional tests. The bulb catheter and bulb bougie are also important aids in the diagnosis and treatment of ureteric stricture or contracture. The wax tipped catheter is employed in the investigation of the ureter for calculus.

Radiographically certain calculi are non opaque and moreover the body of the sacrum obscures a considerable part of the pelvic spindle of the ureter on the radiograph. In these circumstances the sounding of the ureter with a wax tipped catheter and its inspection subsequently under a hand lens for scratches may prove classical aids in the diagnosis of ureteric stone.

THE URETEROGRAM is the radiographic outline of the ureter after the injection of an opaque medium. The retrograde ureterogram is quite as important as the pyelogram and may be made by withdrawing the ureteric catheter as the injection of sodium iodide is nearing completion. By this technique the filling defect of a ureteric tumour may be outlined and an anomaly of the ureter demonstrated. In bifurcation of the ureter the iodide flows into the branch as the catheter is withdrawn. Bifid ureter is not so common as double ureter when the anomaly is bilateral. A ureter which is bifid i.e. bifurcated in its lower segment only is extremely rare. The employment of intravenous urography as an accessory to the retrograde ureterogram has the advantage of providing a photographic record of a moving column of opaque medium. Radiographs taken in rapid sequence with or without compression of the ureters serve to distinguish true contractures or strictures of the ureter from peristaltic waves of contraction and ureteric spasm.

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## CHAPTER XV

### CONGENITAL ABNORMALITIES OF THE URETERS AND THE URETERIC ORIFICES

#### CONGENITAL ABNORMALITIES OF THE URETERS

THESE will be described under four headings —

- A Duplication of the ureter
- B Bifurcation
- C Alterations in the course of the ureter
- D Ectopic ureteric orifice

A Duplication—This anomaly has been found to be present in 3 to 5 per cent of examinations. It may occur as a complete duplication of the ureter



FIG. 83  
Bilateral double ureter

which has then two ureteric orifices or the ureter with a single ureteric orifice may bifurcate in its upward course to the kidney. When a complete double ureter is present the two ureteric orifices usually lie close together on the interureteric ridge (Fig. 83). Under such circumstances the lower ureteric orifice is always that of the division of the ureter leading to the upper segment of a double renal pelvis. The upper segment is the smaller and consists of the upper major calyx system only. Such a kidney is often referred to as a double kidney, although the two segments together equal a normal renal organ. The segments however are independent as regards drainage system and blood supply and may be obviously apart from one another to the naked eye. On the other hand only a faint alteration in the lobulation of the kidney may serve to distinguish a double kidney

with a double ureter from the normal. Duplication of the ureter is much more common as a unilateral anomaly, an incomplete duplication or bifurcation is more common than the complete double ureter.

The anomaly occurs in early embryonic life either by the splitting of the ureteric bud from the Wolffian duct or by the presence of two ureteric buds of independent origin. Since the Wolffian duct is absorbed into the vesical anlage in order to form the trigone it follows that the lower ureter in duplication must be first to gain an independent orifice on the trigone, and thus comes to occupy a more cephalic and lateral position than that of the upper ureter. The latter gains an independent opening to the bladder at a later stage of development and this must be of necessity more caudal and medial in position (Wigart-Meyer law).

*B Bifurcation*—the ureteric split may occur either at the intramural portion or higher up. In both types there is a single ureteric orifice but in the former a ureteric membrane may persist from embryonic life and lead to



FIG 84  
Simple dystopia—pelvic kidney



FIG 86  
Crossed dystopia—unilateral fused kidney



FIG 85  
Simple dystopia—pelvic kidney



FIG 87  
Crossed dystopia—pelvic kidney

stenosis of one segment of the double ureter at the point of bifurcation. While the bifurcation is almost always in a cephalad direction as in Y with a single ureteric orifice, very occasionally the direction may be reversed and from the single pelvis a normal upper ureter may bifurcate caudally to enter the bladder by two ureteric orifices as in A. The lower branch in this type may have an ectopic opening. Occasionally one segment of a duplicated or bifurcated

ureter may terminate blindly. Such an anomaly may present as a small diverticulum opening into the bladder or the ureter otherwise there is an elongated ureteric tube which has no contact with the renal parenchyma (Figs 86 and 87).

**C Alterations in course**—In simple dystopia (Figs 84 and 85), or ectopic kidney the ureter is shortened, whereas in crossed dystopia (unilateral fused kidney) the ureter passes across the mid-line to reach the renal parenchyma. The ectopic kidney has usually an abnormal blood supply from aberrant renal vessels which pass directly from the aorta or iliac vessels. The relations of the affected ureter to the veins are extremely variable. The persistence of a posterior cardinal vein or double vena cava may be associated with a postcaval ureter. This anomaly occurs on the right side and the situation of the ureter behind the vein or surrounded by its branches may lead to kinking and obstruction. In such cases the ureter deviates to the mid-line and lies close to the anterior aspect of the bodies of the vertebrae (Derbes and Dial 1936). In mal rotation of the kidney, and characteristically in horseshoe kidney the ureter lies anterior to the parenchyma of the lower pole, or fused lower poles. The arrangement of the renal veins may be of a foetal type. A double ureter is contained in a common sheath. The ureter from the upper segment of the renal pelvis passes behind that from the lower segment in order to reach the lower orifice on the interureteric ridge. This orifice is always caudal and medial to that of the ureter from the lower segment of the kidney (Weigart Meyer law). The symptoms associated with these anomalies are those of obstruction. Sometimes there are congenital or acquired strictures at the second ureteric orifice or mucous folds may occlude the angle of union in cases with bifurcation (Chwalla, 1927). In the absence of organic stricture kink or fold it is presumed that a faulty neuromuscular mechanism has led to stasis, obstruction and possibly infection or calculus. Undoubtedly the anomaly of double ureter has a higher rate of associated pathology than the normal (Fig 88). In the treatment of upper urinary tract obstruction associated with these anomalies, the successful re-establishment of free drainage by conservative measures may be extremely difficult. In double ureter the upper segment is frequently of small calibre and the common sheath may prevent adequate instrumental dilatation. Likewise bifurcation of the ureter above a single ureteric orifice may defy dilatation and drainage of the narrowed branch by ureteric catheterization.

When actual obstruction and stenosis have occurred in one segment of a double kidney heminephrectomy is preferable to ureterovesical or uretero-ureteric anastomosis (Fig 83). For dysfunction and pain (renal neuralgia) denervation of the renal pedicle with separation of the segments of the ureter may lead to relief. Stenosis of the orifice may require meatotomy using the diathermy electrode or endoscopic scissors before bougies are passed. When there is associated ureteric calculus, treatment may best be carried out by ureterolithotomy, followed by the passage of bougies in a retrograde manner to the bladder through the opening in the ureter.

**D Ectopic ureteric orifice**—Should the ureteric bud from the Wolffian duct appear later than usual in the development of the foetus, an anomaly of implantation of the ureteric orifice may follow. The aberrant implantation of the ureteric orifice may be found (a) in the vesical trigone, in the posterior urethra in the seminal vesicle or ejaculatory ducts in the male and (b) in the female, in the vesical trigone, in the urethra, in the vagina or in the uterine canal. Ectopic ureteric orifice is often associated with other congenital anomalies of the genital and urinary passages. An abnormal

implantation of the ureter into the urethra in the male is usually proximal to the external sphincter, and symptoms affecting micturition vary greatly. In the female there is no sphincteric control of the ectopic ureter, and consequently urinary incontinence is always present.

In the routine investigation of incontinence in the young the possibility of ectopic ureteric orifice has to be kept in mind. Excretion urography and thorough endoscopic inspection after an intravenous injection of indigo carmine form important stages in the investigation. When faulty implantation



FIG. 88

Double ureter with hydronephrosis and hydro-ureter of upper component

of the ureter has led to obstruction and infection in the upper urinary tract nephrectomy is indicated. The need for conservation may, however, render re-implantation of the ureter into the bladder the operation of choice.

#### CONGENITAL ABNORMALITIES OF THE URETERIC ORIFICE

**Introduction**—(1) URETEROCELE (2) URETERIC PROLAPSE and (3) URETERIC STENOSIS present three conditions of the ureteric orifice which have a congenital origin. It is doubtful how each may originate, and as at the bladder neck, the persistence of congenital folds, or valves, and a faulty neuromuscular mechanism have been cited as causal agents. It has been shown that a fault may occur in the embryo during the stage of development from the appearance of the ureteric bud at 12 mm. to the separation of the ureter from the primary excretory duct and cloaca at 28 mm. The urorectal septum divides the cloaca to rectum and urogenital sinus, while a second embryonic membrane guards the opening of the ureteric bud to the primary excretory duct until the ureter gains an independent entrance to the urogenital sinus. It is considered probable that the persistence of such a primitive valve may have a bearing on the aetiology of congenital obstructions at the orifice when the stenosis is almost entirely limited to the epithelium as in ureterocele, and it is possible that an intramural stricture of the ureter, which is apparently primary, may have

a similar origin (Chwalla 1927) Such a viewpoint bears comparison with the origin of congenital atresias in other visceral tubes Both intramural stenosis of the ureter and ureteric prolapse, however, have had further light shed on their possible aetiology by an increasing knowledge of the achaliasias and the effects of their treatment by neurosurgery (Learmonth, 1931) Both lesions might be accounted for by incoordinated action of the ureteric sphincter Anatomically stricture of the lumen and weakness of the sheath are usually coincident in these congenital lesions of the lower end of the ureter

1 **URETEROCELE**—In this condition the site of the ureteric opening in the bladder is occupied by a translucent cyst covered by vesical epithelium The cyst wall is crossed by the delicate vesical vessels of the region of the orifice The cyst balloons out as it fills with the efflux from the ureter and may collapse completely as the urine is discharged into the bladder (Fig 89, c) The contracted orifice may be central on the dome of the cyst, or it may be concealed by the overhanging cyst wall Catheterization may be impossible with the finest catheter owing to stenosis of the opening, and the tendency of the wall to invaginate as it is probed Occasionally the cyst becomes greatly distended and occupies a large part of the vesical cavity A ureterocele may protrude into the female urethra and resemble a polyp The cyst wall consists of an outer covering of vesical mucosa and an inner lining of ureteric mucous membrane The intervening tissue may be entirely areolar, or there may be atrophic muscle fibres from the ureter Campbell (1941) has found ureterocele relatively common in female children who have undergone investigation on account of a recurring pyelitis

2 **URETERIC PROLAPSE**—In contrast with ureterocele this is a true prolapse of the ureteric mucosa into the vesical cavity In the earlier stages the orifice may appear swollen and oedematous with its lips congested and pointing It is raised above the surface and the lumen is central and puckered The margins of the prolapse are found on cross section to consist of two layers of ureteric mucosa In the more advanced stages a portion of the muscular layer may intervene, and the prolapse has come to resemble an intussusception Narrowing of the lumen is not marked and may be accounted for almost entirely by the associated congestion and oedema (Fig 89, b)

3 **INTRAMURAL STENOSIS** and stenosis of the orifice have been found in children in the absence of any primary condition such as calculus or infection The orifice may be reduced to a pin-point opening when viewed through the cystoscope and it may be impossible to pass the finest No 6 Eynard catheter or bougie

THE PATHOLOGY of ureterocele, ureteric prolapse and intramural stenosis is that of the consequent obstruction at the lower end of the ureter, leading to stasis, dilatation and calculus or infection in the kidney and ureter above Rarely, when a ureterocele or a ureteric prolapse of considerable size has formed, there may follow an intermittent irritation and obstruction at the bladder neck which lead to hypertrophy of the bladder musculature and produce the effects of a lower urinary tract obstruction

**TREATMENT**—Ureterocele, ureteric prolapse and intramural stenosis are conditions eminently suitable for endoscopic treatment even in young children In each, treatment is carried out in order to provide efficient drainage from the ureter and kidney to the bladder To this end the contracted meatus and intramural portion of the ureter must be dilated to an adequate calibre An anæsthetic is required In children mbalation anæsthesia is essential, but in adults a low sacral spinal block, or local instillations of planocaine to the urethra and bladder may be employed The operating cystoscope or panendo

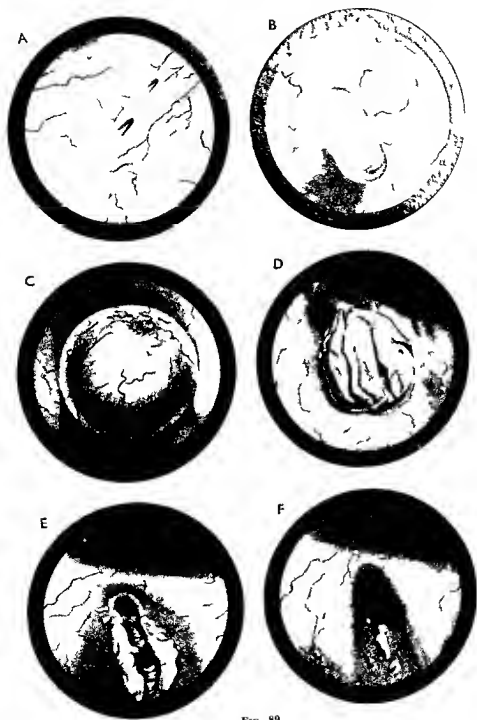


FIG 89

Double ureter    Ureteric prolapse    Ureterocele  
 A double ureter    B prolapse    C ureterocele    D E F appearances after  
 distal anastomosis of ureterocele

scope must be large enough for the passage of ureteric bougies diathermy electrode or Buerger's scissors introduced to the catheterizing attachment in a retrograde manner. When dealing with a ureterocele the translucent wall may be incised by the cutting diathermy current or the wall of the ureterocele may be electro coagulated and meatotomy completed by the endoscopic scissors. With an enlarged meatus of adequate size the ureterocele collapses at once and the ureteric opening may be established as one providing normal drainage (Fig 89 D E and F). In the after treatment the passage of bougies and the measurement of residual urine from the pelvis of the kidney and a pyelo ureterogram serve as indicators of the efficacy of what has been done.

Ureteric prolapse should respond to dilatation of the ureter alone. Bulb bougies should be employed and a close watch maintained for upper urinary tract infection. The treatment of intramural stenosis may be more difficult. When probe pointed catheters or bougies can be passed gradual dilatation may be eminently successful. Occasionally it may be necessary to employ a mechanical dilator such as that made for Bransford Lewis. Diathermic incisions of the contracted ureter should not be attempted when the level of the contracture is above the meatus and out of sight. Although adequate dilatation of the intramural part of the ureter and its meatus has been achieved a permanent atonic dilatation of the ureter alone may suggest a neurogenic lesion of the nature of an achalasia. The peristaltic activity of the ureter may be studied by serial ureterography. When the contractions are defective and there is no infection a hypogastric neurectomy is an operation of proved value (Learmonth).

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## CHAPTER XVI

### INJURY AND FISTULA URETERIC STRICTURE MEGALoureTER

#### INJURY AND FISTULA

**Civil accident**—The ureter in its course in the abdomen and pelvis lies so well protected by the surrounding structures that injury in ordinary accidents is uncommon. Ureteric damage in civil accidents is associated as a rule with accompanying injuries of a severity which overshadows the ureteric lesion. Young (1926) mentions the case of a child who a week after a run over accident developed a painful swelling in the right renal region. Exploration revealed a pseudo cyst which communicated with a small tear in the ureter.

Decoulx (1937) has reported the case of a man who sustained a compound subluxation and separation of the symphysis pubis and sacro iliac joints in an automobile accident. Urine was discharged from the wound from the second to the tenth day. Subsequently a pyelo ureterogram demonstrated a normal renal pelvis but the ureter was seen to be acutely kinked towards the lateral wall of the pelvis. It was considered that the ureter had been torn by sudden traction as the bladder became displaced with the pubis.

**Injury in war**—The wounds of entry and exit of gun shot have been situated in the loin flank or anterior abdominal wall. The reported cases of the 1914-18 war are remarkably few in number. Gordon Taylor (1939) noted that penetrating wounds of the kidneys were accompanied by severe concomitant injuries in 40 to 50 per cent of cases. Everidge (1940) has pointed out that ureteric trauma is but an incident in the grave abdominal complex which follows the penetration of the peritoneal cavity by a missile or missiles. Involvement of the parietes alone may mean serious damage to the vertebræ and spinal cord. Thus injury to the ureter may well be overlooked during abdominal exploration when the surgeon is fully occupied with the repair of injuries to the solid and hollow viscera (Whitby 1941). Even when leakage of urine is recognized during an operation for multiple injuries adequate provision for drainage of the retroperitoneal tissues will suffice. The need for a careful toilet of the contents of the peritoneal cavity overshadows the question of extent of injury to the ureter with a view to repair. The recognition of injury to the ureter as a rule has not been made till during the post-operative course a tell tale discharge of urine appears from a wound made for purposes of routine debridement or abdominal exploration. The free discharge of urine from a wound has not led to local complications and injuries of the ureter leading to fistula have not added to the gravity of cases observed (Everidge 1940).

**SYMPTOMS**—Hæmaturia and fistula together are the characteristic symptoms in injury to the ureter although occasionally a transient hæmaturia may point to contusion of the ureter by a missile. Rarely the urinary fistula has been transient also. It should be remembered that a tear in the ureter has been known to heal spontaneously. A permanent urinary fistula will require to



be dealt with in order to provide for the comfort of the patient. When, as a result of fibrosis with stricture the drainage from the ureter is intermittent or ineffective hydronephrosis and infection occur, accompanied by a tender palpable kidney and toxæmia.

**TREATMENT**—The primary treatment of injuries of the ureter in war will depend on the time available which may be devoted to the ureter, and the amount of damage to be repaired. Uretero-ureteric anastomosis combined with a ureterostomy or nephrostomy is probably an unattainable ideal in operative treatment. A cutaneous ureterostomy would effectively safeguard the kidney from obstruction and infection. Associated injury of the ureter in the pelvis with rupture of the bladder might be treated on lines similar to those employed by Wade (1931) for spontaneous ureterovesical anastomosis following hemicystectomy for tumour. Whatever may be attempted, free drainage of the extraperitoneal tissues to the surface remains a fundamental principle in treatment. For later cases where a urinary fistula is established a full investigation by ureteric catheterization, ureterography and intravenous urography should define the nature and extent of the injury and the likely scope for repair. Occasionally the ureteric catheter may pass to the kidney, and the fistula so enabled to heal without further intervention. It is always wise to delay operative treatment for a month in anticipation of the possibility of spontaneous healing. In established ureteric fistula, nephrectomy is the treatment of choice. In lesions of the pelvic ureter, ureterovesical anastomosis may be possible. When the fistula arises in the abdominal portion of the ureter and it is considered essential to preserve the kidney, cutaneous ureterostomy is preferable to transplantation of the ureter to the bowel, which entails a considerable operative risk.

**Surgical injury**—The greatest number of injuries to the ureter follow surgical operations. They occur almost always in the female. The relations of the ureter in the pelvis may be grossly disturbed by (1) carcinoma of the uterus (2) ovarian lesions, (3) inflammations of the ovary and tube and (4) broad ligament cysts and tumours. In the operative treatment of all pelvic conditions including retroperitoneal tumours, and in the operation for removal of the colon it is important to identify the ureter at an early stage of the dissection. Preliminary ureteric catheterization may be employed as a useful safeguard. The ureter may be subjected to (a) division, (b) ligature, (c) crushing by pressure forceps (d) resection (e) severe stripping with injury to the outer coats and subsequent necrosis.

**SYMPTOMS**—Accidental injury to the ureter at operation may not give rise to suggestive symptoms until some days have passed. Pain and tenderness in the loin and elevation of temperature may be followed by a urinary fistula to the abdominal wound or to the vagina. Where bilateral ligation of the ureter has been carried out there will be anuria. The history of the steps of the operation and a description of the pathological anatomy encountered are of considerable importance when such complications are under review in retrospect.

**DIAGNOSIS**—It is important to carry out ureteric catheterization with endoscopic inspection following the intravenous injection of indigo carmine in order to determine (a) the level of the ureteric lesion, (b) the direction of the fistula and (c) the state of the kidney on the affected side as regards obstruction and infection. Excretion urography is very helpful.

**TREATMENT**—A ureter accidentally ligated at operation may be deligated without harmful effect, even if a number of days have elapsed. When, at the end of a pelvic operation, fears are expressed for the integrity of the ureter

it may be wise to incise the ureter at the pelvic brim and pass a fine catheter down to the bladder. An alternative method is to inject methylene blue to the ureteric lumen through a fine needle and note the appearance of dye in urine withdrawn from the bladder. Longitudinal incisions of the ureter are readily closed by fine catgut sutures which are passed through the adventitia only. They should be loosely tied. Severance of the ureter may be dealt with by anastomosis. The cut ends are trimmed obliquely and again very fine catgut sutures four in number are to be employed. The periureteric tissues may be attached to the line of suture as a reinforcement. Drainage of the kidney must be provided for either by inserting an indwelling ureteric catheter or a ureterostomy can be made above the line of suture. A nephrostomy may be performed. Low down in the pelvis the divided ureter may be reimplanted to the bladder. When a segment of the ureter has been removed and the opposite kidney is known to be present and healthy, nephrectomy is probably the best procedure. A cutaneous ureterostomy can be done rapidly and is a safeguard against renal failure when it is important to conserve function. Double ligation of the proximal end of the divided ureter may lead to renal atrophy but this is by no means constant. Cross ureteric anastomosis and implantation of the ureter to the intestine are operations not to be attempted under the existing circumstances.

In established ureteric fistula following surgical division or injury a full investigation should be carried out to determine (a) the level of the lesion (b) the state of the kidney above and (c) the presence and condition of the opposite kidney. To do this a full urological investigation including function tests and excretion urography will be necessary. The reparative operation need not be conducted until an adequate recovery from the original operation has been achieved. The aim of treatment must be to preserve a functioning kidney and ureter without undue risk. With this object in mind uretero-ureteric anastomosis or reimplantation of the pelvic ureter to the bladder is the operation of choice. When technical difficulties are too great, nephrectomy is the safest and simplest means of ridding the patient of an inconvenient leakage and obviating any risk of upper urinary tract obstruction with infection. Implantation of the ureter to the colon entails a definite risk but may be worthy of consideration when the ureter is of normal calibre and appearance and anatomically lies conveniently approximate to the colon particularly on the left side.

### INFLAMMATION OF THE URETER

**TUBERCULOSIS OF THE URETER** is found almost invariably in association with renal tuberculosis. Infected urine passes down the ureter and the primary implantations of tubercle bacilli to the mucosa are from the lumen. The characteristic lesions of tuberculous follicles are found first at the lower end of the ureter and at the ureteric orifice where they can be recognized cystoscopically. The follicles caseate and ulcerate so that extension of the infection occurs to the submucosal lymphatic plexus where further spread takes place through the ureteric coats to the adventitia and upwards and downwards. Tuberculous granulation tissue leads to considerable thickening of the tube usually associated with irregular narrowing of the lumen. There follow strictures and gross beading of the wall of the ureter which may be demonstrated by ureterography. The fibrosis and subsequent shortening of the ureter lead to the retraction of the orifice which is seen so characteristically when cystoscopy is carried out in the later stages of renal tuberculosis. Tuberculous

granulation tissue and stricture formation interfere with adequate drainage from the diseased kidney, and the obstruction and stasis are responsible for more rapid dissemination of tuberculous infection throughout the kidney. When renal tuberculosis is very chronic the ureter may be found, on exposure, to be as thick as the forefinger. Its consistency may be as variable as that of an arteriosclerotic vessel. Prior to the discovery of intravenous urography, when the diagnosis of renal tuberculosis was frequently no more than presumptive, the demonstration of irregular thickening of a ureter, exposed for diagnostic purposes at the pelvic brim, was regarded as confirmatory. Blockage of the ureter by organization of caseous debris has led to spontaneous apparent "cure" of renal tuberculosis by auto-nephrectomy. The stump of the ureter as a rule shrinks to a fibrous cord after nephrectomy. It is advisable to remove the greater part of the ureter with the kidney at the operation, and no special treatment of the divided distal end is indicated. The short stump which remains is not regarded as the cause of persistence of vesical ulceration.

### URETERIC STRICTURE

**A Organic**—A stricture of the ureter may occur after trauma such as that caused by the impaction of a calculus, or following injury. Fibrous strictures also arise as a result of inflammations of the ureter which have led to cellular infiltration of the wall of the ureter. These are commonly seen at the levels where anatomical points of narrowing are present between the abdominal and pelvic spindles of the ureter, i.e. the ureteropelvic junction, the level of the crossing of the iliac vessels, and the intramural portion at the entrance to the bladder. Tuberculous strictures are multiple and very characteristic. Neoplastic strictures may be due to tumours primary in the ureter, or invading the ureter wall from without, e.g. carcinoma of the cervix. All such strictures are secondary to a primary lesion, traumatic, infective or neoplastic, which is the originator of the principal symptoms for which the patient comes under observation.

**PATHOLOGY**—The ureter is constricted by an infiltration of its wall as a result of inflammation or neoplastic disease. In consequence there is obstruction at the level of the stricture, and urinary stasis, and dilatation of the ureter above this point. Stasis, infection and obstruction form a vicious and reversible sequence in the pathology of the urinary passages, especially the ureter. The effects of stasis are hydronephrosis and dilatation. When this is followed by infection there is a dissemination throughout the kidney leading to suppurative pyelonephritis. Periureteritis, by binding the kinks of a tortuous and dilated ureter, effectively prevents any possibility of recovery, until a free drainage has been established.

**SYMPTOMS**—These are referable to the readily distended and sensitive renal pelvis. Intermitent attacks of renal colic may be accompanied by a dull ache in the loin which persists between the exacerbations. The kidney is enlarged and palpably tender. In the presence of infection there are fever, toxæmia and a marked pyuria. The diagnosis of stricture of the ureter may be confirmed by ureteric catheterization and pyelography.

**TREATMENT**—When there is a simple stricture of the ureter, which is permeable to the ureteric catheter, dilatations with aspiration of the residual urine should be carried out at fortnightly intervals until free drainage has been re-established, and the pyelo-ureterogram returns to normal. Dilatations are most effectively carried out by means of bulb catheters or bougies until

a calibre of 11 F has been attained. Bulb bougies require to be introduced to the operating cystoscope or the panendoscope in a retrograde fashion if an adequate range of dilators is to be passed. Usually the bougies are graded from size 7 F to size 16 F but for practical purposes dilatation to 11 F will be found effective. Reactivation of infection, pain and febrile disturbance can only be avoided by meticulous attention to an aseptic and gentle technique. A tortuous ureter may be perforated by too vigorous instrumentation. When stricture of the ureter with associated hydronephrosis and recurring infections is a unilateral lesion, palliative treatment on the above lines may never bring about a complete recovery with freedom from symptoms and ill health. In these circumstances nephrectomy is to be recommended. In depressed renal function or with bilateral lesions regular treatment by dilatation and the maintenance of ureteric drainage may conserve the renal parenchyma and prolong the patient's life in considerable comfort. Impermeable stricture of the ureter with dilatation of the upper urinary tract and infection is best dealt with by nephrectomy though should it be necessary to preserve the kidney a cutaneous ureterostomy or reimplantation of the ureter to the bladder may be carried out.

**B Ureteric spasm or stricture or ureteritis (Hunner's stricture).—**The above terms are used indiscriminately to describe a clinical entity described by Hunner (1911, 1916, 1926). The feature of this condition is a pain in the line of the ureter which is intermittent in character and elicited by the passage of a bulb ureteric catheter. The nature of the lesion is not fully understood and it may not be recognized by intravenous and retrograde pyelography (Morison 1934). It is suggested that the lesion may be of the nature of a spasm similar to that produced by neuromuscular incoordination in pylorospasm and cardiospasm i.e. an achalasia.

**SYMPTOMATOLOGY.—**Evidence of ureteric spasm is found usually in those segments of the ureter which normally exhibit narrowing. These segments give rise to symptoms referable to certain areas or zones on the abdominal wall which are painful. Thus pain arising in zone 1 (the ureteropelvic junction) is referred to the subcostal area and the loin. Pain in zone 2 (where the ureter crosses the iliac vessels) is referred to just below and lateral to the umbilicus. Pain in zone 3 (where the ureter is in apposition to the broad ligament in the female and to the vas in the male) is referred to the inguinal region. Pain in zone 4 (where the ureter passes through the bladder wall) is referred to the area above the symphysis pubis (Morison 1943). For diagnostic purposes it is a feature of a ureteritis of this type that the symptom of pain in the zone complained of can be reproduced by the passage through the affected segment of the ureter of a bulb bougie or ureteric catheter. It is held that the intercommunications of the ureteric nerves explain the wide variations in the distribution and the character of the pain in ureteritis or ureteric stricture of the Hunner type (see *Innervation of the Ureter* p. 163). Thus a pain in zone 1 may be associated with nausea and a feeling of abdominal distension. Pain in zone 2 has been brought on by exertion or conversely recumbency. Pain in zone 3 has been associated with the menstrual period. Pain in zone 4 with mild urinary bladder infections.

**PATHOLOGY.—**Hunner and Wharton (1926) have described varying degrees of small cell infiltration at the segments of the ureter affected by this clinical entity as described above. They believe that minimal histological changes in the ureter may lead to the alterations in sensitivity from which the symptoms arise.

**DIAGNOSIS**—The problem of abdominal pain of an indeterminate type, is one that requires both application and ingenuity for its elucidation. The specialist in every branch of medicine has, very often, a different explanation to offer and where orthodox pathological lesions in the alimentary, reproductive and urinary systems have been excluded, psychopathic states have been proffered. The clinical examination of a patient who has been subjected to a number of abdominal operations may be baffling in the extreme. Patients with complaints of pain in the abdominal areas described in the above zones must be examined systematically, from both subjective and objective standpoints. The investigator must guard against the use of leading questions and the pitfalls of eliciting diagnostic data by suggestion. Ureteritis (Hunner's stricture) of the type under consideration does not produce well-circumscribed physical signs, and the symptomatology may include factors attributable to dysfunction in any bodily system. The urinalysis, both chemical and bacteriological, is negative, and ordinary urological examination, including ureteric catheterization and pyelography, yields no positive finding of diagnostic value. It is stressed that the endoscopic manipulations should be carried out with the full co-operation of the patient and with a meticulously gentle technique. Hunner's stricture, or an unduly sensitive segment of the ureter, may be recognized by the passage of a bulb bougie, which gives rise to a sensation of pain as the bulb passes through the affected segment. The pain complained of is identical with that which brought the patient under observation. Finally, as the bulb bougie is withdrawn a definite resistance is met with as the bulb passes through the "stricture." This feature is described as a hitch or a hang in the withdrawal of the catheter, which has been gripped by the lesion in the ureter to the accompaniment of pain. From what has been written above it may be concluded that a diagnosis of ureteritis or Hunner's stricture depends largely on a subjective symptomatology, and that variations in the intensity of the signs, elicited by the cystoscopist during catheterization, may differ widely according to the methods and instruments employed, and the temperament of the urologist.

**TREATMENT**—When a painful ureteritis, spasm, or Hunner's stricture of the ureter has been diagnosed, treatment is carried out by a series of dilatations of the ureter by graduated bulb bougies. The instrumentation may be undertaken at intervals of two weeks, and it is considered effective when a bulb bougie of size 11 F can be made to pass through the sensitive segment without causing pain. This is a standard criterion for the adequate patency of the ureter, such as might be employed in the after-treatment of such conditions as stone in the ureter, hydronephrosis, and ureterovesical lesions. Ureteric dilatation however, should not be employed indiscriminately, and endoscopic instrumentation should be reduced to a minimum in subjects of a highly sensitive temperament. When ureteric spasm persists in spite of appropriate measures for the elimination of underlying sources of irritation, courses of short-wave diathermy may be usefully employed. Rarely it may be necessary to have recourse to denervation of the ureter (Wharton 1934).

### MEGALoureTER

Idiopathic dilatation of the ureter in children may occur to a degree comparable to that of the colon in Hirschsprung's disease or megacolon. The term megaloureter implies an idiopathic dilatation of the ureter due to neuro-muscular incoordination of the ureteric wall and the ureterovesical opening, i.e. an achalasia. It is known that a contraction of the ureteric orifice follows

stimulation of the corresponding hypogastric nerve and that the sympathetic innervation of the pelvic portion of the ureter is derived from the superior hypogastric plexus (presacral nerve) the left or right hypogastric nerve and the inferior hypogastric plexus (Learmonth 1931 Learmonth and Braasch 1933 Gask and Ross 1937 Mitchell 1938). A certain measure of success has followed the division of the presacral nerve or the corresponding left or right hypogastric nerve in bilateral or unilateral megalounter respectively. The results of sympathectomy have certainly upheld the view that megalounter is caused by a sympatheticotonus which has inhibited effective peristalsis in the ureter and reciprocal relaxation of the ureterovesical orifice. Campbell (1937) has suggested that the neuromuscular derangement may



FIG 90  
Bilateral megalounter



FIG 91  
Bilateral megalounter with  
hydroureter

be associated with a persistence of the disproportionately large foetal type of ureter.

**Pathology**—In megalounter the dilatation is most marked at the lower end of the ureter. In mild cases the dilated pelvic portion of the ureter may be accompanied by a relatively normal abdominal portion and the renal pelvis and the calyces remain unaffected. The greatest dilatation is juxta-vesical. This contrasts with the effects of organic obstruction of the ureteric lumen as in calculus or stricture when the renal pelvis and calyces are dilated even in the earliest stages of any obstruction which produces backward pressure. Further the ureteric orifice is not incompetent and appears normal structurally. Bilateral megalounter due to achalasia may thus be distinguished from the bilateral dilatation of the ureters accompanied by widely incompetent ureteric orifices which follows from a prolonged infravesical obstruction. The naked eye appearances of the ureter in the earlier stages are those of a thin walled tube which is dilated. There is a marked tendency to tortuosity as the distended ureter kinks. In the later stages when stasis has been complicated by infection small cell infiltration and fibrosis of the wall associated with periureteritis render permanent the kinks of a tortuous and fixed ureter. Failure of sympathectomy to bring about a return of normal peristalsis and reduction in the calibre of the ureter is due in many cases to the inflammatory changes

which have supervened in the atonic ureter, and the fixation brought about by periureteritis. In the most advanced cases recurring attacks of infection and pyelitis lead to renal insufficiency and suppurative pyelonephritis.

**Symptoms**—There is no symptomatology for megaloureter until infection has led to pyelitis and persistent or recurring urinary tract infection in children. In very young children polyuria and signs of urinary toxæmia may overshadow those of pyelitis with pain in the loin and frank pyuria. Very occasionally the distended ureter may be appreciated by inspection or palpation of the thin abdominal wall (Thomson-Walker 1936).

**Examination**—Intravenous urography is valuable as a means of detecting earlier stages of megaloureter. But when the condition has become established with a considerable degree of atony and dilatation, the depressed state of renal function and the large quantities of residual urine in the renal pelvis and the ureter prevent adequate visualization of the urinary tract. At a cystoscopic examination the ureters appear to be normal and may be catheterized easily. Large quantities of residual urine are withdrawn. Ureterograms are characteristic. There is a dilatation of the ureter which terminates abruptly at the ureterovesical orifice. The term "snake's head appearance" has been used to describe the blunted termination of the dilated tube. The dilatation is most marked in the lower third of the ureter, but in the more advanced cases the dilatation is continued proximally and associated with tortuosity. The kidney is often hydronephrotic. In order to gain some knowledge of the tone of the ureter, screening after injection of opaque medium and withdrawal of the ureteric catheter is of value as a guide to treatment. Should eserine by subcutaneous injection, or, better, a spinal anæsthetic lead to a return of peristalsis it may be assumed that the achalasia may respond to treatment, or at least be controlled.

**Treatment**—This may primarily be carried out by dilatation of the ureteric orifice and the withdrawal of residual urine from the ureter by catheter aspiration. The response of the ureter to the relief of over-distension may be reflected in a return of more vigorous peristalsis seen by screening. In mild cases such endoscopic treatment may suffice. In view of the neuropathic basis of megaloureter, however, and an increasing knowledge of the sequelæ of muscle atrophy and fibrosis in the ureteric wall which lead to an irremedial atony and dilatation, it is now considered advisable to perform a sympathectomy when there is evidence of contractility and peristaltic movement following eserine or spinal anesthesia. The choice of operation is simple when the megaloureter is unilateral and the corresponding hypogastric nerve alone need be resected. In male children with bilateral megaloureter an effective sympathectomy means a presacral neurectomy. This operation leads to sterility by preventing ejaculation, and should not be undertaken without full regard for the circumstances. In cases of unilateral megaloureter with infection a nephro-ureterectomy is the most effective treatment, but when bilateral dilatation renders ureter to the bladder by endoscopic or transvesical meatotomy. Whichever ureteric catheter should be retained for forty-eight hours in the post-operative period in order to ensure adequate drainage. When drainage of the ureter is still inadequate following endoscopic ureteric meatotomy, re-implantation of the ureter into the bladder at open operation has proved to be a procedure of permanent value.

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## CHAPTER XVII

### OPERATIONS ON THE URETER

**T**HE situation of the ureter beneath the peritoneum of the posterior abdominal wall, its structure and physiology give rise to surgical problems which are not met with elsewhere in the body

**Drainage of the kidney**—Nephrostomy is advocated in many procedures carried out on the upper part of the ureter in order to (1) ensure drainage in case of obstruction by swelling, (2) maintain renal secretion in case of raised pelvic pressure (3) lower the pressure on the suture line, (4) overcome renal sepsis by procuring adequate drainage. In spite of a satisfactorily functioning nephrostomy only 50 per cent of the pelvic urine is said to be diverted from passing down the ureter

**Drainage of the bladder**—The rise of pressure in the lower end of the ureter is dependent almost entirely on the pressure in the bladder. This can be much reduced by suprapubic drainage. It is for this reason, and also to limit the possibility of infected urine passing back up the ureter, that drainage of the bladder is advocated in the majority of operations on the lower end of the ureter

**Drainage of the ureteric bed**—Accurate and well spaced suturing of the ureter should prevent leakage of urine, but if the wall should have been unavoidably damaged, sloughing and delayed union frequently occur. The presence of urine in the retroperitoneal tissues quickly results in a marked inflammatory reaction which may rapidly become infected. Swift Joly stresses the danger of leakage of urine causing infection of the urinary tract and recurrent stone formation. Therefore it is always advisable to provide adequate drainage to any suture line in the ureter

**Indwelling ureteric catheter**—Some urologists advocate leaving a ureteric catheter in the ureter after any operation upon it in order to (a) act as a splint (b) drain urine from above, (c) prevent obstruction to the flow of urine by oedema. Others believe this procedure is harmful by causing local infection and increased liability to stricture formation

### THE APPROACHES TO THE URETER

**Exposure of the lumbar segment**—This segment of the ureter extends from the ureteropelvic junction at the level of the transverse process of the second lumbar vertebra to the transverse process of the fifth lumbar vertebra. The exposure of this portion of the ureter is usually part of an exploratory operation on the kidney, so that one should be able to expose both structures through the same incision

**OPERATIVE TECHNIQUE**—The patient is placed in the kidney position on the table, the under thigh being fully flexed and the upper thigh extended. The arm of the affected side is supported in an arm rest, and the kidney bridge is raised

The incision starts at the apex of the angle formed by the twelfth rib

and the sacrospinalis muscle about two and a half inches from the posterior mid line. It is carried downwards and forwards parallel and half an inch below the twelfth rib towards a point two inches above and two inches in front of the anterior superior iliac spine (Fig 92). The more distally the ureter has to be explored the further forward the incision must be carried. This incision is more oblique than the usual kidney incision but it is to be preferred to the J L or T incision as it gives a better exposure and can be more easily closed.

If the kidney needs to be explored it is exposed in the usual way and the



Fig 92

Oblique renal incision for approach to the lumbar segment of ureter

ureter can be traced down from the renal pelvis. But if the ureter alone has to be investigated it can be found by the following landmarks: it will be inside the wide sheath of fascia (urogenital) and just medial to the lower pole of the kidney from which this fascia can generally be seen passing downwards. Adherence to the peritoneum occurs usually just below this point so that it should be looked for on the undersurface of the peritoneum the spermatic or ovarian vessels cross and separate it from the peritoneum at the level of the transverse process of the third lumbar vertebra. It may be followed upwards from the brim of the pelvis which it crosses at the bifurcation of the common iliac vessels (Fig 95). If it is hard to find the ureter at the lower



pole of the kidney by pressing the kidney upwards the ureter is made taut and can be more easily felt.

If the ureter has been inflamed a fibro fatty mass may develop around the duct and will need careful dissection with a knife until a line of cleavage is found between the wall of the ureter and the fibrous tissue. The exposure of the ureter may also be difficult if there has been acute inflammation of abdominal viscera involving the peritoneum to which the ureter is adherent; this duct may then have to be freed from thick scar tissue. If the ureter has been much dilated and the walls have been thinned as a result palpation of

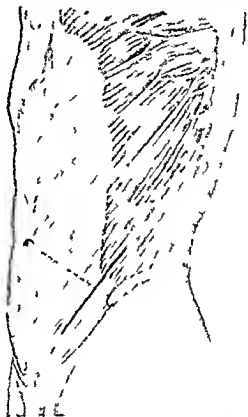


Fig. 91

Iliac incision for approach to iliac segment of ureter

this tube may be very difficult and it can be easily confused with a loop of the small intestine.

Once the ureter has been found it can usually be separated from the peritoneum with ease by finger or gauze dissection and can be brought well into the wound.

The blood vessels passing to the ureter from the neighbouring sources may be torn in the stripping of the ureter but seldom cause much bleeding.

**Exposure of the iliac segment**—This segment of the ureter extends from the level of the transverse process of the fifth lumbar vertebra to the point at which it crosses the brim of the pelvis.

**OPERATIVE TECHNIQUE**—The patient is placed either in the kidney

position or lying on his back with a pillow placed beneath the buttock of the affected side so as to empty the iliac fossa as much as possible of viscera.

The incision is a continuation of the oblique kidney incision. From the loin it passes through the point two inches above and internal to the anterior superior iliac spine and runs parallel to and two inches above Poupart's ligament. It ends one inch medial to the lateral edge of the rectus sheath and has its mid point on a line joining the anterior superior iliac spine to the umbilicus (Fig 94). The underlying muscles may be divided in the line of the skin incision or they may be split as in a McBurney's grid iron incision the former giving the better exposure but leaving a weaker abdominal wall. Whichever method is employed it is advisable to divide the external oblique fascia more extensively than the muscle as this structure tends to diminish

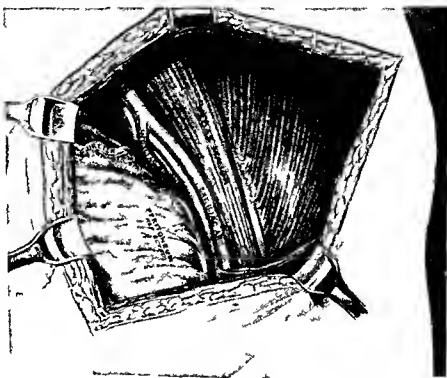


FIG 95

The brim of the pelvis exposed by the iliac approach

the exposure more than any other. Care is taken when incising the transversalis fascia that the peritoneum beneath—which in thin patients may be closely related—is not opened and it may be advisable to introduce a guide through a small hole and divide the fascia upon it. If the muscles have been divided it is easiest to identify the peritoneum in the loin where it is not so closely adherent as it is on the anterior abdominal wall and to separate it inwards before finally cutting the transversalis muscle and fascia. The anterior leaf of the rectus sheath is incised in order to give more room medially.

The peritoneum is raised from the iliac fossa by digital and gauze dissection. This should be easy unless an inflammatory process has taken place within the iliac fossa. The spermatic or ovarian vessels will be met as the ureter is approached. The stripping of the peritoneum is continued until one can palpate the psoas major and the spinal column then it is carried down wards until the common iliac vessels and their bifurcation are exposed (Fig 96).

When the origin of the internal iliac artery has been identified by palpation if the finger is then rotated so that the volar surface turns forwards and inwards it should feel the ureter on the reflected peritoneum as a ribbon like structure. In a small percentage of cases the ureter will be found nearer the mid line even on the promontory of the sacrum. The ureter once identified can be followed upwards and downwards. A gauze sling placed around the ureter can be made to draw the duct well into view in the wound if it has been stripped for a short distance from the peritoneum.

When the operative procedures on the ureter have been finished and it

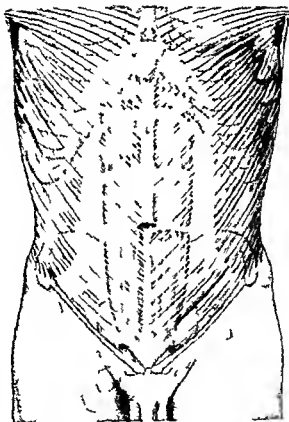


FIG. 96

It opens on for approaching the pelvic segment of the ureter

is decided to drain the ureteric bed care must be taken that the drainage tube does not lie upon any blood vessel as pressure necrosis may result with severe bleeding.

**Exposure of the pelvic segment**—After crossing the brim of the pelvis the ureter passes downwards and backwards beneath the peritoneum of the posterior wall of the pelvis. It then curves forwards and inwards along the floor of the pelvis crossing the tip of the spine of the ischium to reach the posterior wall of the bladder two centimetres from the mid line.

The choice of the route of approach will depend upon which portion of this segment requires exposure. If it is the portion just below the brim of the

pelvis or that which passes down the posterior wall which requires exploration then the ilio pelvic approach is usually employed. The portion passing along the floor of the pelvis or that immediately behind the bladder is best approached by a pararectal or mid line incision.

**The ilio pelvic approach—OPERATIVE TECHNIQUE—**The patient is first placed supine on the table with the buttock on the affected side raised on a pillow. If later it is found that greater exposure is needed he may be placed in the Trendelenburg position.

The incision starts at a point two inches above and internal to the anterior

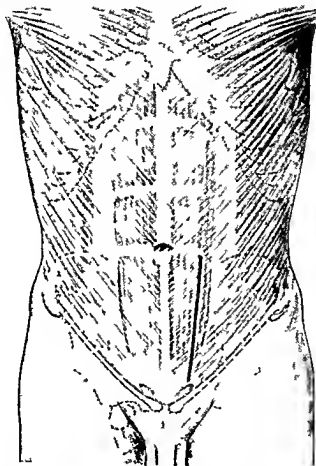


FIG. 97

I. Pararectal incision for approach to the pelvic segment of the venter

superior iliac spine and is carried downwards and inwards parallel to and two inches above Poupart's ligament to the lateral border of the rectus sheath (Fig. 96).

This incision is deepened either by dividing the muscles of the abdominal wall or by splitting them in the line of their fibres. If the muscles are split the transversalis fascia will be incised in the line of the skin incision and care is taken not to open the peritoneal cavity. The deep epigastric arteries will be met in the course of this incision and should be ligatured and divided.

The peritoneum is raised from the brim and lateral and posterior walls of the pelvis but care must be taken as the peritoneum is very thin in this

situation. The spermatic or ovarian vessels will be met before the ureter is exposed and must be preserved. This stripping will continue until the promontory of the sacrum is reached. The bifurcation of the common iliac vessels is identified and on the reflected peritoneum which has been raised from in front of the internal iliac artery the ureter should be felt. If there has been much periureteritis the ureter may be found adherent to the bony pelvis and not to the peritoneum.

The ureter is gently stripped off the peritoneum with the finger or small pad of gauze for such a distance as to enable the necessary manipulations to be carried out.

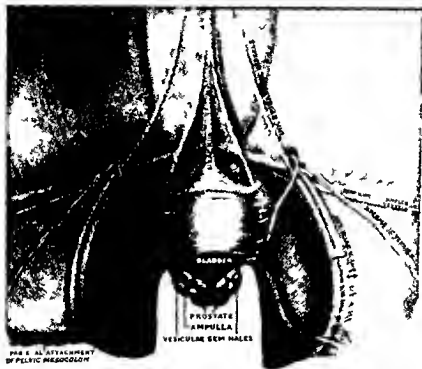


FIG. 93

Posterior surface of anterior abdominal wall and anterior half of the pelvis

When draining the ureteric bed by this route great care must be taken to see that the tube does not press upon any blood vessel especially those on the brim of the pelvis or severe hemorrhage may result.

**The pararectal approach—OPERATIVE TECHNIQUE.**—The patient is placed on his back either flat or in a slightly tilted Trendelenburg position. If the operation is being carried out in order to remove a ureteric calculus especially if the ureter is dilated above the site of impaction of the stone it may be unwise to tilt the table in case the stone slips back up the ureter.

The incision is made medial to the linea semilunaris and parallel to it extending from the symphysis to the umbilicus (Fig. 97). The rectus sheath is incised in the line of the skin incision and the lateral edge of the rectus muscle freed.

The rectus muscle is retracted inwards the intercostal nerves passing to



the subumbilical portion of the rectus are carefully preserved, while the inferior epigastric vessels which are usually found on the posterior layer of the rectus sheath are divided between ligatures (Fig. 98).

The posterior layer of the rectus sheath is carefully incised so as not to open the peritoneal cavity. The peritoneum is stripped from the bladder and the lateral wall of the pelvis, and the bladder from the side of the pelvis so as to give adequate exposure of the side of the pelvic cavity (Fig. 99).

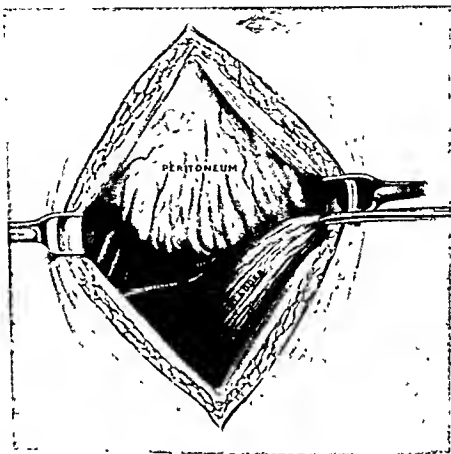


FIG. 99  
Pararectal approach to lower half of pelvic ureter.

The ureter is identified (a) by retracting the wall of the bladder medially and forwards, then by following the vas deferens, which will be seen as it passes from the internal inguinal ring, backwards to the posterior wall of the bladder; it crosses the ureter as the latter pierces the bladder wall; (b) at the brim of the pelvis as the ureter crosses the bifurcation of the common iliac vessels; (c) if the spine of the ischium is palpated by the finger the ureter will be found on that portion of the peritoneum which lies immediately above it; (d) if the ureter is not being explored for a stone, a catheter passed up the ureter from the bladder will render it more easily palpable.

The ureter will be freed from the peritoneum just sufficiently for it to be brought up to the surface of the wound. This approach allows drainage of the ureteric bed to be carried out without fear of pressure-necrosis by the drainage tube on vessels.

**The rectus-splitting approach**—This is a variation of the pararectal approach. The rectus abdominis muscle, instead of being displaced inwards or outwards, is split vertically, in so doing, advantage is taken of the fact that the nerve supplying the lowest segment of this muscle enters its lateral edge just above the symphysis pubis and immediately divides into two branches, one supplying the outer half the other supplying the inner.

The muscle is split between these two halves. But it is most important that the muscle is not separated down as far as the point at which the nerve enters the muscle or the inner branch may be torn. The rest of the operation is carried out as in the pararectal approach.

**The median approach**—This approach is usually employed when the juxta vesical portion of the pelvic ureter requires exposure. Or it may be used to explore the intramural portion of the ureter when this cannot be approached through the transvesical route.

**OPERATIVE TECHNIQUE**—The patient is placed in the Trendelenburg position unless there is fear of a calculus slipping back up the ureter. Some urologists find that the normal supine position is satisfactory, although tilting the table helps to displace viscera into the upper abdomen. The incision is made in the mid line from the pubis to the umbilicus, the surgeon standing on the opposite side to that on which the ureter is to be exposed. The apex of the bladder is defined and is steadied with a pair of tissue forceps so that the peritoneum can be stripped from the roof of the bladder and sides of the pelvis. Then by separating the bladder from the wall of the pelvis it is possible to work backwards while pushing the peritoneum upwards and inwards, thus gaining a good exposure of the region at the back of the bladder. In the course of stripping the peritoneum from the roof of the bladder the vas deferens will be met, and this will lead to the point at which the ureter passes into the bladder (Fig 99). If a stone is present it may be palpable and will indicate the ureter. If the ureter cannot be found on the floor it will be necessary to expose it at the brim and follow it down on to the floor. The spine of the ischium is a landmark over which the ureter passes in its course across the pelvic floor. If the ureter still cannot be found and a calculus is not present a ureteric catheter should be passed by means of a cystoscope.

In the case of a stone in the lower end of the ureter in a female patient, the method of approach will depend on whether the stone is above or below the uterine artery, if above this artery then it is best to expose the ureter at the brim of the pelvis and work down, if it is below the uterine artery then by retracting the bladder the lowest portion of the ureter is put on the stretch and can be traced from the vesical end.

It may be difficult to get a good view of the juxta vesical segment of the ureter and a stone may have to be removed largely by cutting down on to the resulting fusiform swelling which is held between finger and thumb. This approach also allows drainage of the ureter with complete safety, and the tube is brought through the suprapubic wound.

**The transvesical approach**—This is used exclusively to gain access to the intramural portion of the ureter. It is carried out either through an operating cystoscope or by opening the bladder suprapubically.

**Endoscopic approach**—This is used either to enlarge the ureteric orifice so that an intramural stone can pass or to free a stone impacted just inside the ureteric orifice—

(a) By cutting with an electrode the bladder mucosa which overlies a stone impacted at the ureteric orifice. The line of the incision should include

the edge of the ureteric orifice and extend upwards and outwards in the line of the intramural ureter

(b) The ureteric orifice and the submucous portion of the ureter can be laid open by means of Buerger's cystoscopic scissors. In order to prevent hæmorrhage, it is advisable first to coagulate the line of the incision with a diathermy electrode

(c) Special ureteric meatotome have been devised to slit the ureteric orifice. Ogier Ward's meatotome has a concealed knife which can be passed up the ureter to the required distance, the knife is then extruded through the mucosa, and as it is drawn back towards the bladder a coagulating diathermy current is passed through it to prevent hæmorrhage. Lane has devised a meatotome from which a tungsten wire is advanced and by means of a cutting current the ureteric orifice is cut upwards as far as necessary.

**The suprapubic approach**—The position of the patient is a matter of choice for the surgeon, some prefer the Trendelenburg position, others find the supine position satisfactory. The bladder is opened by the mid line subumbilical route. Bladder retractors are inserted and the floor of the bladder examined.

The ureteric orifice is identified and the blade of a fine pair of sharp pointed scissors is inserted and the submucous course of the ureter laid open. The stone may be felt and can be removed with a scoop or stone forceps (Fig 100).

After removal of the stone, the bladder must be drained suprapubically to minimize the danger of ascending pyelonephritis.

Thomson Walker described a transvesical approach to the juxta vesical portion of the ureter when the extravescical approach has been found difficult. A curved incision with the concavity towards the ureteric orifice is made one and a half inches lateral to the orifice. A flap of bladder is turned down and by pulling upon this flap the ureter can be made tense and easily definable (Fig 100). After removal of a stone the ureter is sutured and the bladder repaired with catgut around a rubber tube which passes through the wound into the retrovesical zone and is brought out of the suprapubic wound, the bladder also being drained.

The intramural portion has been slit upwards and backwards until a juxta vesical calculus has been removed, but this results in much deformity of the intramural portion of the ureter and the incised area is difficult to drain (Fig 100).

The bladder has been opened through the vagina and a calculus removed from the lower end of the ureter. But this is not a procedure to be advocated as the danger of a vesicovaginal fistula alone is sufficient to condemn it.

**The transperitoneal approach to the pelvic segment**—This approach is most useful when there has been much retroperitoneal inflammation causing the peritoneum to become firmly adherent to the iliac fossa and pelvic walls. Also when the ureter has been damaged during surgical operations on the pelvic organs, when scarring may render the identification of this duct difficult by any other route. But in the majority of cases the extraperitoneal approach is to be preferred.

**OPERATIVE TECHNIQUE**—The patient is placed flat on the table until the peritoneal cavity has been opened, when it will be found that the Trendelenburg position by displacing the intestines out of the pelvis, will aid considerably the exposure of the course of the ureter.

A subumbilical mid line incision is made to open the peritoneal cavity. The table is now tilted and the intestines are displaced and packed off in the

upper abdominal cavity. The ureter will be sought for at the brim of the pelvis in the groove lateral to the promontory of the uterus. The bifurcation of the common iliac vessels is the principal landmark or, in the case of the left side, just medial to the internal iliac artery on the posterior pelvic wall.

The left ureter passes behind the parietal attachment of the pelvic mesocolon. In order to expose it in this position, the pelvic colon is raised so as to stretch the inferior leaf of the mesocolon, the peritoneum is incised at the reflection of this mesocolon on to the pelvic wall at the point at which the common iliac vessels are felt to bifurcate.

If possible, the peritoneum should not be opened immediately over the

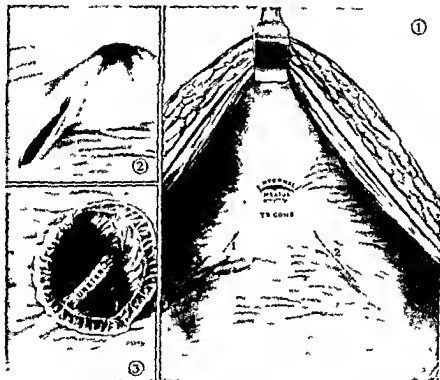


FIG. 100

Transverse approach to the ureter. (1) Incision of subcutaneous course of ureter. (2) Transureteric approach to juxta vesical portion of the ureter. (3) Thomson Walker's transverse exposure of the juxta vesical portion of the ureter.

point at which the ureter will be incised, but some distance from it in order to avoid damaging the sheath and blood supply of the ureter as far as possible and to prevent urine leaking into the peritoneal cavity.

From the brim of the pelvis the ureter can be traced downwards until in the female it passes beneath the broad ligament and in the male it can be followed up to the bladder where it is crossed by the vas deferens. In the female, after passing beneath the broad ligament the ureter is surrounded by an extensive venous plexus which can cause much bleeding if the duct has to be freed from its bed. The ureter then passes beneath the uterine artery before it reaches the bladder. When the ureter has been found some urologists prefer to close both peritoneal wounds because of the danger of

**LEAKAGE OF URINE**—An incision in the ureter which has been sutured carefully should not leak urine but if sloughing has occurred of a portion of the wall some urine may drain from the tube for several days but will almost invariably close of its own accord

If no sutures are inserted into a ureter which has been opened longitudinally it will close of its own accord but only after leaking urine for some time

**CELLULITIS**—A mild degree of cellulitis probably occurs in many cases in which a stone has been removed from the ureter but if drainage has been provided it rapidly clears up There are some case reports of a severe spreading retroperitoneal cellulitis but they are rare

### URETEROTOMY AND URETEROLITHOTOMY

The ureter is seldom opened except to remove a stone so that the terms ureterotomy and ureterolithotomy are almost synonymous if the term ureteroplasty is reserved to describe the division of a stricture The position of a stone impacted in the ureter will have been localized by X ray or if it is not opaque to X rays its position will have been approximately determined by the dilatation of the ureter above an apparent narrowing as shown by an intravenous pyelogram or the point at which an opaque catheter is obstructed in its passage up the ureter

**Operative technique**—The patient is placed on the table in the position advised in the previous section depending upon the segment of the ureter which has to be exposed Many surgeons advise that when the ureter is dilated above an impacted stone no tilting of the table should be carried out and the patient be only turned with great care in order to avoid the possibility of displacing the stone up the ureter towards the kidney

The segment of the ureter which is to be explored is approached by one of the routes suggested above

Usually the stone is held up one to two inches from the bladder in the male and just above the broad ligament in the female

If stones are known to be present in the kidney as well as in the ureter those in the ureter must be removed first even if those in the kidney have to be left until they can be removed at a subsequent operation

When the ureter has been exposed the stone will either be palpated within its lumen or be seen as a fusiform swelling in the course of the duct

The ureter above the stone is often dilated and this dilatation may be marked if the stone has been present some time

As soon as the stone has been localized care should be taken to prevent it slipping back towards the kidney preferably by compressing the ureter above the stone with a finger until a pair of tissue forceps can be placed around the duct so as to restrict the ureter without damaging it It is advisable not to manipulate that portion of the ureter immediately overlying the stone for fear of damaging further the wall and its blood supply

The ureter is gently stripped from the peritoneum by the aid of a gauze swab sufficiently to allow the portion containing the stone to be brought to the surface of the wound This may be most conveniently carried out by placing slings of gauze around the ureter one above and the other below the stone but tension must be avoided as the duct may rupture

In the case of a calculus being impacted in a ureter which is held down by adhesions and cannot be mobilized without danger of severely contusioning

level at which the obstruction was anticipated then it must be followed downwards to the extremity of the dilatation. If it is not dilated at the suspected level then the ureter should be traced towards the kidney.

**THE LOSS OF THE CALCULUS BY RETROGRADE PASSAGE UP THE URETER.**—The stone may have slipped back towards the kidney between the time the last X ray was taken and the exposure of the ureter at operation or it may occur during the operation. It is especially likely to occur if the ureter is dilated. The distance the stone passes backwards varies if it previously lay just outside the bladder it seldom passes back beyond the brim of the pelvis. While only those stones which lie in the region of the brim of the pelvis slip back to the renal pelvis but exceptions do occur to this rule.

The retrograde passage may give rise to a serious surgical problem usually there are three courses open to the surgeon (1) to postpone the removal of the calculus until it has returned to its original site this should only be adopted if the condition of the patient does not allow of further operative interference (2) localization of the fresh site of the calculus and the exposure of this segment either by extending the incision upwards or by making a fresh incision this can only be done if X rays are available in the operating theatre during the operation (3) by opening the peritoneal cavity preferably in the mid line and palpating the upper urinary tract with the fingers the calculus should be identifiable by this route in any portion of the ureter and renal pelvis except perhaps the calyces and on finding the stone it may be possible to manipulate it back into the portion of the ureter which is already exposed. The peritoneum must be closed before the stone is removed from the ureter. This is the procedure of choice.

**RUPTURE OF THE URETER.**—A dilated ureter is easily torn if it is pulled upon and the rupture usually occurs at the site of the impaction of a stone. The dilatation of the proximal portion of the ureter makes anastomosis with the contracted distal portion unlikely to be successful it is better to implant this segment into the bladder if this can be done without tension if not it may be necessary to remove the kidney provided the other kidney is competent.

## URETERECTOMY

Ureterectomy or the excision of the ureter may be partial or total.

**Partial ureterectomy.**—This is most frequently performed when the kidney is removed the amount of the ureter which is excised depending on the pathological state of the ureter and the ease with which the duct can be freed. The lower end of the ureter may have to be removed if it has become infected or infiltrated by new growth the upper half having been removed at a previous nephrectomy.

Small portions of the ureter may have to be excised in operations for valves stricture fistula and injury but such procedures are rare.

**OPERATIVE TECHNIQUE.**—The ureter will be approached by the most suitable route to the segment involved which will give ready access and adequate exposure. The ureter is stripped from the peritoneum for the distance which will allow the necessary manipulations. If a repair operation is to be carried out the less the ureter is disturbed and manipulated the greater the chances of success.

**Total ureterectomy.**—The resection of the whole length of the ureter is invariably associated with the removal of the kidney. The removal of the kidney and the whole ureter at the same operation is known as a nephro-

ureterectomy the removal of the ureter is then referred to as a primary ureterectomy. If the kidney has been removed and the major part of the ureter has been left, the later removal of this duct is then referred to as a secondary ureterectomy.

The whole length of the ureter may have to be removed if infection occurs in a ureter which has become dilated as a result of a congenital abnormality, stricture or calculus. But more frequently the removal is necessary for a tuberculous or neoplastic involvement of the ureter.

**NEPHRO URETERECTOMY (primary ureterectomy)**—Formerly it was advocated that the kidney and ureter should be removed through an incision starting in the renal angle and passing downwards and forwards to a point two inches in front of and above the anterior superior iliac spine. From there it was carried on parallel to, and two inches above, Poupart's ligament to the rectus abdominis sheath. Through this exposure access to the kidney and the whole length of the ureter can be easily obtained, but, although it should divide no nerves, it leaves a weak abdominal wall and has been largely given up.

It has been found more satisfactory to remove the kidney and ureter through two separate incisions. The kidney and the ureter as far as the brim of the pelvis are exposed through an oblique incision which starts at the apex of the renal angle and is carried to a point two inches above the anterior superior iliac spine. The kidney is freed and the renal vessels ligatured and divided. The ureter is now stripped from the peritoneum to the brim of the pelvis. The wound in the loin is sewn up in layers, except for a small space at the lower end through which the ureter passes. The patient is turned on his back and the pelvic course of the ureter is exposed through a pararectal or median subumbilical incision. Provided the intramural portion of the ureter does not need removal, the ureter can be divided proximal to the bladder between clamps, the ends are ligatured and cauterized. Having freed the pelvic ureter up to the pelvic brim so that it can be freely moved with the abdominal segment, the lower wound is closed with a drainage tube to the ureteric bed, and the whole ureter withdrawn from the lumbar wound which is also drained.

If the intramural portion of the ureter has also to be removed, this should be done transvesically either at a subsequent operation or at the same operation if the patient's condition will stand it. The bladder is opened and a circular incision is made around the ureteric orifice, this is deepened until a button of bladder wall with the ureter attached is freed. The ureteric orifice is cauterized and sutured, and it is pushed back into the retroperitoneal tissue of the pelvis. The hole in the bladder is sutured and the bladder and retrovesical tissues drained. The whole ureter is then withdrawn from the loin.

**Two-stage ureterectomy**—The decision to remove the ureter in two stages may have been made prior to operation or during the course of the operation. Or the ureteric stump which had been left at a previous nephrectomy as unlikely to cause trouble, may give rise to symptoms which necessitate its removal.

At the first stage the kidney is removed. The ureter may either be mobilized as far down as possible and the proximal end ligatured, cauterized and replaced in the retroperitoneal space as near the brim of the pelvis as possible, or it may be brought out at the lower end of the wound and sutured there. At the second stage, the ureter is exposed in the pelvis by a pararectal or median approach, the lower end is divided just proximal to the

bladder and is freed backwards and upwards until the upper half is reached and freed. The whole length of the ureter is withdrawn and the retroperitoneal space drained.

### URETEROPLASTY

Ureteroplasty is the term applied to those operations which aim at enlarging the lumen of a constricted ureter so it is usually reserved for strictures of the ureter either congenital or acquired.

**OPERATIVE TECHNIQUE**—The site and degree of the stricture having been previously determined by descending and ascending pyelography the portion of the ureter involved is exposed by the appropriate route. The ureter is stripped from the peritoneum for a short distance above and below the site of the stricture. If the ureter is dilated above the stricture the retained urine may be infected and should be aspirated by means of a hypodermic needle and syringe.

The ureter is drawn to the surface of the wound by gauze slings passed around the duct above and below the stricture. The wall of the ureter is then incised longitudinally through the stricture and for a little distance above and below. The longitudinal cut in the ureter is then sutured with interrupted plain catgut sutures (No. 0 or 00) transversely. The site of the suture is drained for a few days by a rubber drainage tube.

Marion advises the passage of a ureteric catheter upwards towards the kidney; the lower end of this catheter is passed down the ureter into the bladder and is brought through the urethra by cystoscopic forceps. He then sutures the incision in the ureter over this catheter which is left in place for a few days.

### INTERNAL DIVISION OF A URETERIC STRICTURE

A ureterotome was invented by R. Dos Santos in which a concealed knife could be advanced out of a flexible catheter at the site of the stricture.

### URETERIC ANASTOMOSIS

**Ureteropelvic anastomosis**—The anastomosis of the ureter to the renal pelvis is almost entirely confined to the treatment of hydronephrosis and will be described in the chapter dealing with that condition.

**Uretero-ureteric anastomosis**—**OPERATIVE TECHNIQUE**—The segment of the ureter requiring the anastomosis is approached by that route which gives the most direct and best exposure as it is essential to have sufficient space to carry out the anastomosis. The ureter must be mobilized and stripped from the peritoneum for a sufficient distance to allow the opposing ends to be brought together without tension. There are three types of anastomosis which have been employed: (a) end to end (b) end to side (c) side to side.

The end to end anastomosis is the most frequently employed method as it requires less mobilization of the ureter to obtain union without tension. The ends may be cut transversely the method requiring the least mobilization and therefore useful when there has been loss of tissue owing to resection of some portion of the ureter but such an anastomosis tends to stenose (Fig. 102 A). Therefore an oblique division of the opposing ends is preferable if sufficient ureter can be mobilized as this type of anastomosis does not tend



to stenose (Fig 102 B) The tendency to stenosis may be even further diminished by splitting longitudinally the obtuse side of the obliquely cut ureter (Fig 102 c) The cut ends are joined by interrupted sutures of fine plain catgut (No 0 or 00)

There is some difference of opinion as to whether a catheter should be left in the ureter after the anastomosis, those in favour believe it drains the renal pelvis when œdema of the suture line would otherwise obstruct and also acts as a splint Others believe that it is conducive to stricture formation

If the kidney is infected but cannot be removed, a nephrostomy carried

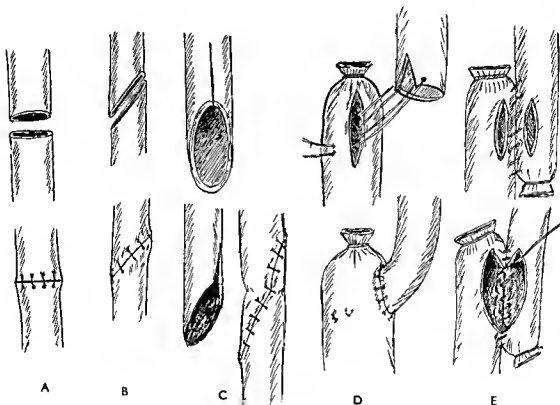


FIG 102

A Transverse end to end anastomosis of the ureter B Oblique end to end anastomosis of the ureter C, Oblique end to end anastomosis with a longitudinal split of the obtuse side D End to end anastomosis with a longitudinal split of the upper segment on one side E Side to side anastomosis of the ureter

out at a previous operation may improve the chances of successful anastomosis, but it is said that it will only divert about 50 per cent of the urine from passing down the ureter

An *end to side anastomosis* has been advocated by some surgeons By this method the distal portion of the ureter is ligatured, a longitudinal incision of half an inch is made into the lumen just distal to the ligature The upper end having been divided transversely, has a split of quarter of an inch made on one side to prevent stenosing of the end A catgut suture is passed through each corner of this split, the ends are threaded on needles, which are passed through the incision in the distal segment and out through the opposite wall By pulling on these sutures the upper end can be made to invaginate

into the lower and also to spread the split wide open thus diminishing the likelihood of stenosis. The edges of the wound in the lower segment are then sutured to the wall of the upper so as to produce a watertight anastomosis (Fig. 102 d).

*Side to side anastomosis*.—This is probably the best method when the upper segment is dilated more than the lower. Both ends of the ureter are ligatured. A longitudinal incision is made in both the ligatured segments of about three quarters of an inch. The edges of the incisions are sutured with fine plain catgut so as to form an adequate stoma (Fig. 102 e).

*Ureterovesical anastomosis*.—The implantation of the divided end of the ureter into the bladder may be carried out by the transperitoneal retroperitoneal or the transvesical routes, the choice will depend upon the circumstances which necessitate the ureter being implanted.

The usual cause for the anastomosis of the ureter into the bladder is the involvement of the lower end by a vesical new growth or by a diverticulum. But it may also be called for if the lower end of the ureter has been damaged in an operation on the pelvic organs. In the latter condition the transperitoneal route will probably be indicated as the amount of scar tissue makes the extraperitoneal route difficult.

*TRANS-PERITONEAL ROUTE FOR URETEROVESICAL ANASTOMOSIS*.—*Operative technique*.—The patient is put into the full Trendelenburg position. A subumbilical mid line incision is made to open the peritoneal cavity. The intestines are displaced into the upper abdominal cavity and are retained there with gauze packs.

The ureter is defined at the pelvic brim and is followed down towards the bladder. If a fistula has formed as a result of damage during a pelvic operation and it is found inadvisable to attempt a uretero-ureteric anastomosis, the ureter will be freed sufficiently to allow it to be implanted into the bladder without tension. The end of the ureter is now split longitudinally on opposite sides of its circumference for half an inch and a catgut suture is inserted through each of the halves. The bladder having been rendered quite empty by a catheter is opened by a small incision about half an inch long at the site at which the ureter is to be anastomosed. Through this incision the sutures mounted on needles are passed and are brought back through the bladder wall so that when they are pulled tight the ureter will be drawn into the bladder and the two halves will be spread out in the manner of a T. The edges of the wound in the bladder are now sutured by interrupted catgut sutures around the circumference of the ureter in two rows. The first inch of the ureter is buried by folding over it the bladder wall by interrupted sutures. The peritoneum is repaired and the peritoneal cavity closed. The bladder is drained suprapubically, some surgeons also like to drain the extravescical space at the anastomosis by an extraperitoneal tube if this can be fairly easily carried out. A catheter passed up the ureter on the affected side is thought by some to allow drainage and maintain a channel while healing is going on which might otherwise be obliterated by oedema.

*TRANS-VESICAL ROUTE FOR URETEROVESICAL ANASTOMOSIS*.—This method is employed when the lower end of the ureter has become involved by a vesical new growth or diverticulum so that the removal of either cannot be carried out without damaging the ureter.

*Operative technique*.—The patient is placed in the Trendelenburg position. The bladder is opened by a mid line suprapubic incision. The new growth or diverticulum will have been dissected away from the bladder. The ureter

is exposed on the external surface of the resected flap. It is freed sufficiently to be brought down into the bladder without tension. The ureter is divided across as close to the bladder as will leave a healthy end for implantation (Fig. 103).

The wound in the bladder is sutured in layers and the ureter is brought through this wound and fixed to the bladder mucosa with interrupted catgut sutures. Thomson Walker placed a small rubber tube alongside the implanted ureter which passed through the bladder wall and drained the retrovesical space. This rubber drain is sewn in with catgut and is left in place until the catgut is absorbed. This tube acts not only as a drain but leaves a weak

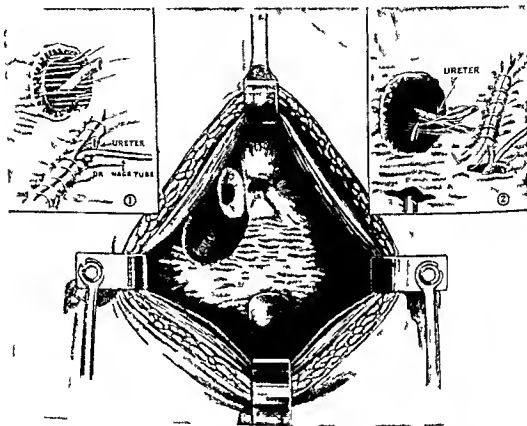


FIG. 103

Transvesical retrovesical anastomosis. Inset 1—Thomson Walker's method of implantation of ureter. Inset 2—Marion's method of implanting the ureter into the bladder.

spot in the vesical scar which prevents the ureter from becoming constricted by scar tissue (Fig. 103 inset 1).

Marion believes that it is inadvisable to bring the ureter directly through the wound in the bladder. He advises splitting the lower end of the ureter so as to form two tongues. Through the end of each he passes a suture. An oblique tunnel is made in the bladder wall about two centimetres from the edge of the bladder wound and passing towards the ureter by means of a trocar. Down this tunnel a pair of forceps is passed and the sutures in the ends of the ureter grasped and drawn down the tunnel together with the ureter. A spindle shaped excavation is cut with a pair of curved scissors at the exit of this tunnel which allows the split ends of the ureter to be spread out like a T and sutured to the edges of the depression. The wound in the bladder is now sutured

A ureteric catheter is inserted up the ureter and brought out through the urethra and is left in for five days. The bladder is drained suprapubically.

### IMPLANTATION OF THE URETERS INTO THE SKIN

This method of draining the kidneys was previously popular when total cystectomy was performed and when urine had to be diverted from the bladder for vesical tuberculosis or irreparable vesicovaginal fistula. It has been largely superseded by the implantation of the ureters into the bowel which avoids the discomfort of the leakage of urine and the wearing of an apparatus to collect the urine. Nevertheless some surgeons carry out this operation on account of its low post operative mortality.

**Operative technique**—The patient is placed in the kidney position. The lumbar and iliac segments of the ureter are exposed by an oblique renal incision as described above.

The ureter is defined from just below the kidney to the brim of the pelvis. It is stripped from the peritoneum as far distally as possible. The ureter is ligatured and divided over a gauze pad in order to catch any infected urine which might escape. The distal end is allowed to fall back into the retroperitoneal space. It is most important to obtain a sufficient length of ureter in order to avoid kinking or tension of the implanted ureter.

The proximal end is split longitudinally for half an inch and a rubber ureteric catheter is passed along it for a short distance.

The point of implantation in the skin wound may be posteriorly in the lumbar region or in the anterior part of the wound. The former being most frequently carried out.

The wound in the loin is now closed in layers and the split end of the ureter is spread out and sutured to the skin. Thomson Walker advised bringing a rubber drainage tube out alongside the ureter so as to produce a weak spot in the scar tissue in order to avoid constriction of the ureter by scar tissue.

The ureteric catheter will be left in for five days in order to avoid obstruction of the ureter by oedema and to ensure drainage of the kidney. A special ureterostomy apparatus is fitted when the wound is healed.

This operation can be performed on both kidneys at the same time or, if the condition of the patient will not allow it, the ureter of the opposite side can be implanted at a later date.

J F SEMPLE

### TRANSPLANTATION OF THE URETERS INTO THE BOWEL

Since the British surgeon John Simon in 1851 first transplanted the ureter into the lower colon in man, surgeons the world over have been attracted by this problem and numerous attempts have been made with the assistance of countless animal experiments to develop the operation and to place it on a secure footing. The method as here described has evolved from the

methods of Stiles of Edinburgh and Coffey of Portland, Oregon USA and has largely replaced all others and is now recommended as the best thus far devised

**Indications**—When this operation was first introduced it was almost limited to cases of (1) ectopia vesicæ but it has proved the best method of dealing with (2) other congenital defects associated with incontinence such as total epispadias in either sex It is indicated in those cases of (3) vesicovaginal fistula in which it has proved impossible to carry out a local repair It has also been employed in some few cases of (4) injury above the triangular ligament where the surgeon has failed to restore the urethra Transplantation is by far the best method of (5) diverting the urine preparatory to excision of the bladder for carcinoma where the disease arises primarily in that viscus or has extended from some surrounding parts such as the cervix It has also been used in cases of (6) inoperable new growth as a means of giving physiological rest to the bladder by applying the principle of the short circuit Transplantation is also the best means of relieving the miseries of the (7) systolic bladder after excision of the kidney for tuberculous disease Doubtless there are other indications and it has recently been tried in some cases of (8) incurable cystitis As the object of the operation is to use the lower bowel as a urinary reservoir it is essential before carrying out the method to be sure that the rectal sphincteric mechanism is competent

**General physiological results**—The urine is stored in the large bowel rather than in the rectum and investigations have shown that it may often flow round to the cæcum From the bowel the urine is voided per rectum from time to time The intervals between evacuations of the bowel vary but most patients can comfortably retain urine for about three hours Some can sleep through the night without emptying the rectum while others require to rise once or twice for that purpose This partly depends upon the time of retiring and on whether the patient drinks abundantly last thing at night Usually the material voided consists of urine and faeces intimately mixed but some patients may pass more or less normal stools at one time and fairly clear urine at another In all cases the urine is heavily infected and strongly alkaline but in spite of this proctitis does not occur and there is usually an absence of irritation about the anus Most patients have perfect control, in others there may be a little involuntary escape at times, and some few have incontinence, but the latter is usually only at night time The rectal function depends to some extent on the general health Within the first three weeks after operation the ureters and renal pelves usually show some dilation as demonstrated by urography This may disappear or persist and in a few cases a degree of hydronephrosis develops The latter probably depends on kinking or stenosis about the site of the anastomosis It is not necessarily progressive, and pyonephrosis is an unusual complication The profound alteration in the economy of the body does not interfere with general development or well being Ten patients closely observed over periods of from fifteen to thirty three years after the operation were able to stand up to their ordinary environment and to work and play like normal individuals In females, marriage can be consummated and child bearing is possible, one patient being the mother of three healthy children all born without difficulty after the transplantation Even males with gross deformity have sought the consolations of matrimony and not always to the disillusionment of their partners

**Principles of the transplantation**—The operation consists in intraperitoneal exposure of the ureters, which are divided close to the bladder and are then implanted directly into the lumen of the lowest part of the pelvic colon

The implantation is made obliquely into a submucous bed in the bowel wall so that the ureter passes directly from its retroperitoneal course into the bowel without any kink or twist. The ureter must not be compressed during its course through the bowel wall either by the sutures, extravasation of blood or the products of infection. A portion of the extremity of the ureter should be redundant inside the bowel so that a nipple like projection results with the lumen of the ureter in its centre. This is probably the best safeguard against narrowing of the orifice. There must be no infection of the site of anastomosis as this might lead to pressure on the ureter from inflammatory exudation, or to thrombosis with consequent necrosis, or to so much softening that the ureter would retract away from the bowel and give rise to fistula. The technique has now been very much simplified, and is carried out without any special apparatus. Clamps are not used either for the ureter or for the colon, Coffey's tubes are no longer employed, and Charles Mayo's catgut guide has been discarded. Fine 3/0 or 6/0 chromic catgut is used for sutures. Drainage is not usually employed.

Should both ureters be transplanted at the same sitting?—Up till quite recently it has usually been considered safer to transplant one ureter at a time, and the wisdom of this course has been borne out by statistics. With better understanding of the problems involved a simpler technique and more knowledge of after-care, surgeons are tending more and more to carry out a simultaneous transplantation except in children and even in them the hazards of a second anæsthetic may perhaps balance the only slight extra risk of the double transplantation.

**Preliminary investigation and preparation**—Whenever feasible excretion urography should be used in order to demonstrate the condition of the renal pelvis whether or not the ureters are dilated and the presence of anomalies like double ureter. It is necessary to take the customary steps to determine that the renal function is satisfactory and the operation should not be undertaken until this is assured. Where renal function is embarrassed as the result of obstruction with dilatation of one or other renal pelvis with or without infection, preliminary drainage of the kidney may so improve the condition that the operation of transplantation may be safely carried out while the kidneys are still draining on to the loins. In cases where the improvement after renal drainage is only slight it is better to defer the transplantation, if necessary for months. No attempt need be made to sterilize the bowel but the action should be regulated and it ought to be thoroughly emptied on the day preceding the operation so that the patient may reach the table with the large bowel as nearly empty as possible. It may be helpful to endeavour to protect the kidneys against cob infections by the administration of pot. cit. in adequate doses for forty eight hours preceding operative interference. Prophylactic chemotherapy with the sulphonamides has not been employed in order to avoid nausea, as it is most important that the patient should drink freely as soon after operation as possible.\*

**The operation**—It is essential that there should be perfect relaxation. In most cases this can be secured by inhalation anæsthesia if the patient has been well prepared and if the anæsthetist is sufficiently experienced. When there is chronic cough, or in very big bulky patients spinal anæsthesia should be used. In children there has been a considerable mortality as a result of post-anæsthetic chest complications, and spinal anæsthesia should be considered. With proper precautions as to dosage this method is suitable in the young.

The abdomen is opened by one of the anterior vertical incisions. The

\* Some of the new preparations are better tolerated

mid line is satisfactory and is especially indicated in the cases of congenital anomaly where the linea alba is a wide sheet of fibrous tissue and the recti are widely separated. If the operation is done in two stages that is to say one ureter at a time the original incision can be re opened for the second stage and if carefully closed there is no special risk of incisional hernia. Either before or just after opening the abdomen it is essential that the patient should be placed in the Trendelenburg position. The small intestine should be encouraged to slide out of the pelvis or should be packed away. The next step is the exposure of the ureter as a rule the right ureter is dealt with first.

In children or thin adults it is readily seen through the peritoneum passing over the common iliac artery just before its bifurcation. In other circumstances and especially in stout patients the ureter may not be so obvious and may have to be searched for in the retroperitoneal cellular tissue. In any case an incision is made through the posterior parietal peritoneum over the line of the ureter this should be about 2 in long and should extend from the pelvic brim down towards the bladder. The ureter is quite characteristic in appearance but confirmation is furnished by vermication which may either occur spontaneously or can be initiated by stroking the ureter or by gently pinching it with a pair of plain dissecting forceps. After identification it is to be gently isolated by blunt dissection from the surrounding cellular tissue in which it lies. The ureter is conveniently surrounded by a ring forceps or a tape to provide a handle during manipulation. It should not be held with a crushing forceps.

During this process of separation some vessels of supply may be torn but no vessel is to be deliberately divided. When 2 or 2½ in of ureter has been separated from its bed it is clamped with an artery forcep at the lower extremity which will be near its entrance into the bladder. The ureter is then cleanly cut across on the proximal side of the forceps with sharp scissors or a scalpel and the lower end in the grasp of the forceps securely ligatured with chromic catgut carbolized and allowed to retract into the cellular tissue. When the ureter is unusually small it should be divided obliquely in order to increase the terminal lumen. The wall of the ureter above the point of division is caught with very fine dissecting forceps and at this stage it is convenient to put in a stitch which is later to be used for drawing the ureter into the bowel and for fixing it there. This stitch is of fine catgut and is passed with a round needle introduced into the lumen of the ureter for ¼ in then out through its wall and is then tied so lightly as not to cut its way out or to strangle the tissue in its grasp (Fig 104). The ends of this suture are left long and the ureter is turned back over a piece of gauze. This kinking by turning back will be enough to prevent the escape of urine and avoids the use of a clamp across the ureter. The edges of the incision in the posterior parietal peritoneum are drawn together with two or three interrupted sutures.

In cases where only one ureter is to be transplanted the next step is to prepare the bed in the bowel but in double transplantation the opposite ureter should next be exposed isolated and divided. To determine the point of implantation the ureter is to be laid on the surface of the bowel at the point it would naturally reach in continuation of its oblique retroperitoneal course. An area of the bowel is selected which is either in the first part of the rectum or the lowest part of the sigmoid and will be the part of the bowel which is easily accessible in the particular build of patient with which the surgeon happens to be dealing. This line is then demarcated by introducing a guide stitch at either end of the area which will be about 1½ in long and will extend to the opposite edge of the anterior longitudinal band (Fig 105). By drawing on the guide sutures the area is put on the stretch and made ready for the

oblique incision. If there are any obvious vessels crossing the line of the proposed incision these should be underrun with a fine suture and tied.

With the bowel on the stretch an incision is made along this oblique line through the peritoneum and muscular coats down to but not through the mucous membrane. In making this incision it is a help to place the first two fingers of the left hand behind the bowel and to press them forward. This manoeuvre steadies and flattens out the bowel and provides a level background for the knife. If the muscle does not retract sufficiently to expose an elliptical area of the outer surface of the mucous membrane it can be encouraged to do so by a light touch of the knife held on the flat or by being gently opened up by the points of a pair of blunt forceps as is often necessary in the Rammstedt operation for congenital stenosis of the pylorus.

All bleeding having been controlled a small incision is now made into the lumen of the bowel at the lower end of this oblique cut. To make this opening the mucous membrane is held up between forceps. A very small opening will suffice as it readily becomes larger on even the gentlest manipulation. The fixation stitch previously introduced into the end of the ureter is now rethreaded on a fine round bodied needle which is then passed through the aperture into the lumen of the bowel and is brought out by piercing the wall  $\frac{1}{2}$  in lower down. The two ends of the fixation suture may be separately passed through the bowel about  $\frac{1}{2}$  in apart or after being passed through together one end must take another bite of the bowel so that when the ends are tied the ureter is pulled up against the inner wall and fixed there in the position selected.

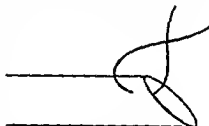


FIG 104  
Shows method of applying fixation suture to divided ureter

The next stage is to suture the muscular wall of the bowel over the ureter in its submucous bed using a series of interrupted stitches. Usually five such stitches are sufficient to draw together the incision of  $1\frac{1}{2}$  in in length. These are tied the end sutures being left long to provide a means of steadying the bowel. A further series of sutures are now introduced in the Lembert fashion, commencing by burying the ends of the fixation stitch i.e. the point  $\frac{1}{2}$  in beyond the end of the oblique cut and the first row of sutures. To do this effectually will require about two more sutures than have been employed for burying the ureter. It is most important to take care that the ureter is not in any way compressed where it enters the infolded bowel wall. Should this happen the ureter will probably be noticed to distend above the last suture and this is an indication for releasing one or more sutures and reapplying them less firmly. The ends of the last suture are left long and at the conclusion of the implantation are used to anchor the bowel to the cut edge of the parietal peritoneum so that the adjacent side of the bowel lies snugly against the pelvic brim. In this way at the conclusion of the operation the ureter passes directly from its retroperitoneal bed into the bowel so that it has no intraperitoneal course. All these matters are shown in the diagram (Fig 105).

If the second ureter is to be transplanted at once the same steps are taken but the incision in the bowel wall should be  $1\frac{1}{2}$  in higher up than the first implantation (Fig 106). It is probably safer to implant both ureters into the same side of the bowel and to anchor the bowel to the



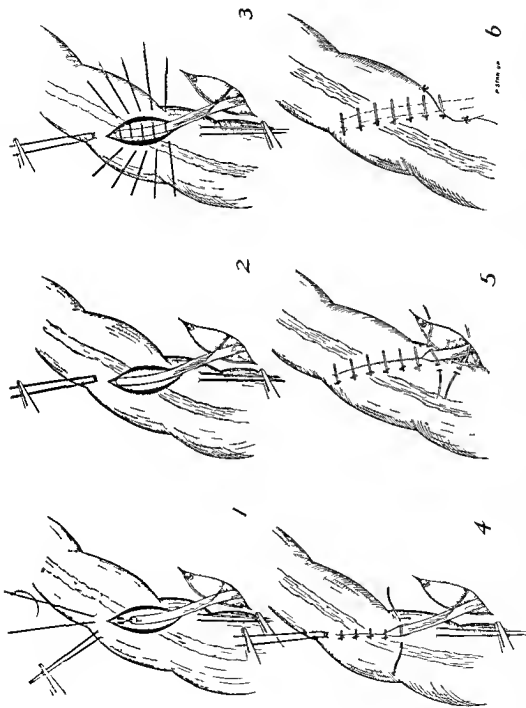


FIG 105

Transplantation of ureter into pelvic colon. (1) Submucous bed prepared. (2) Ureter in position and fixation suture tied, being drawn into lumen of bowel by means of traction sutures held in artery forceps, ureter replacing tractor suture which has been removed. (3) Sutures inserted for drawing edges of muscular coat together. (4) Muscular sutures being tied to secure approximation but without tension. (5) Lambert sutures to bury the first layer in muscular coat; the fixation suture has now been cut short. Two sutures in position, which when tied will anchor bowel to parietal peritoneum. (6) Transplantation complete. Note: ureter following normal oblique course without kinking or constriction, also absence of tension.

parietal peritoneum on that side of the pelvis. To carry this out the left ureter should be isolated and divided on its own side of the colon and should then be passed to the right side behind the mesosigmoid (Fig 106). If the ureters are transplanted into opposite sides of the bowel the parietal peritoneum should only be lightly sutured to the bowel in order to cover the ureter so that no part of that structure is exposed in the peritoneal cavity.

After completing the toilet of the peritoneum the omentum is crowded into the pelvis and the patient brought to the horizontal position for closure of the abdomen. For some three years now drainage from the site has been omitted but it is a perfectly rational safeguard and the surgeon need not hesitate to employ it a fine tube about  $\frac{1}{8}$  in in outside diameter being brought from near the site of implantation and out at the lower end of the abdominal incision or through an independent small incision in the iliac fossa.

The abdominal wall must be very carefully closed some through and through sutures should always be used. As a last step a tube about forefinger size is passed through the anus into the ampulla of the rectum and fixed to the anal margin by suture. This is to prevent the accumulation of a puddle in the rectum which might encourage ascending infection. The whole procedure takes from three quarters of an hour to an hour and a half depending upon whether one or both ureters are transplanted and of course the customary speed of the operator.

**MODIFICATIONS**—Most of the numerous plans that have been evolved during the last few years have been rendered unnecessary by the success of the simple technique just described. Some surgeons believe that it is safer to make the implantation largely extraperitoneally. An oblique incision in either iliac fossa is employed only one ureter being dealt with at a sitting. They argue that if leakage occurs there is no risk of peritonitis.

**DIFFICULTIES**—Occasionally it may be difficult to identify the ureter and especially where there is periureteritis or deep X ray therapy has been employed. In these circumstances the ureter may be thickened and rigid and may not vermiculate. The ureter is very constant in its course over the pelvic brim but it may adhere closely to the peritoneum and be pushed aside with that structure. No other anatomical structure has the same position or takes the same course though sometimes in children the obliterated hypogastric artery may be the cause of a little doubt but it does not vermiculate and is a rounded cord which does not flatten when palpated between the finger and thumb. If the ureter is unusually friable the transplantation may have to be made much higher up—perhaps 3 in. below the kidney.

The unexpected discovery of a much dilated ureter may be embarrassing. Such ureters have been transplanted with success by the method just described but it may not be possible to bury them in the usual way as this may lead to obstruction by infolding. In these circumstances the cut end of the ureter may be sutured end to side to an incision in the sigmoid just a little larger

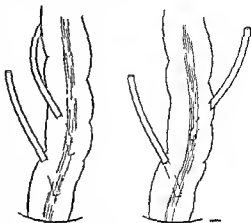


FIG 10

Showing the alternative methods of disposition of the ureters mentioned in the text

than the lumen of the ureter. The union may then be tucked into the bowel by one or two loosely applied purse string sutures as in the Kader Senn type of gastrostomy. Double ureters of the same size should usually be independently transplanted but if one is very small it may be doubly ligatured and divided at its lower end the principal ureter being transplanted in the usual way. If the double ureters lie so closely side by side as to be virtually one double barrelled structure they may be transplanted together as though single.

**IMMEDIATE AFTER PROGRESS AND TREATMENT**—There should be no shock and very little upset of any sort. Urine may be discharged into the rectum from the outset but it is more usual for ureasis to be delayed for about six hours. If there has been any doubt about the activity of the renal function the patient should reach the ward with a glucose saline drip *in situ* and this is continued until there is a free discharge of urine from the rectal tube. When the patient recovers from the anæsthetic the drinking of hot water is allowed and in the absence of vomiting or distension encouraged. In forty eight hours or so the patient may be able to take some solids and thereafter soon desires ordinary diet. Some patients vomit a good deal and a moderate degree of distension is not uncommon. Such symptoms nearly always clear up as soon as ureasis is freely established.

If there is no evidence of renal secretion by the end of six hours active steps should be taken to encourage it. It is only in cases with rather poor renal output or in which ureasis is delayed that the intravenous sodium sulphate 4·3 per cent is employed\*. The rectal tube should be removed in four days or earlier if it is much resented. Thereafter there may be incontinence for some days especially in children and adults may have very frequent calls—perhaps every hour. They may be able to exercise control for about an hour at a time by the end of a week. Even children acquire rectal control quite quickly and nearly always by the time they are ready to leave hospital in three or four weeks. Of course some education is usually necessary and to this end it may be a help to keep the bed pan in the bed. A capable and understanding nurse will usually manage to assist even small children to acquire control within this time. There is never any difficulty about movement of the bowel for the flow of urine into the colon acts as a sufficient stimulus. If distension persists and the tongue is dirty one grain of calomel is helpful. Nematia should be avoided for fear of disturbing the site of anastomosis. Pituitary may be required.

**IMMEDIATE COMPLICATIONS**—Injury, chest troubles, peritonitis, extra peritoneal inflammation and ascending renal infections are the infrequent troubles under this head. Retroperitoneal inflammation must especially be borne in mind in malignant cases with some infection of the ureters. Persistent distension, local tenderness in either iliac fossa, quickening pulse, elevated temperature, anorexia and general malaise about a week after operation are very suggestive of intra- or extraperitoneal infections about the site of anastomosis. Such conditions are grave but not necessarily fatal. A localized abscess may form and after evacuation either through the wound or by incision may be followed by urinary fistula and recovery. Some infection of the kidney used to be so frequent as to be looked upon as part of the normal convalescence but in more recent years it has seldom occurred possibly owing to the simplification of the technique. When it occurs most cases turn out to be mild but even so the onset may be sudden and alarming and attended with considerable general disturbance and high temperature. As a rule this

\* 4·3 g. of hydrated sodium sulphate (Clauber's salt) dissolved in one litre of distilled water gives an exact solution of 4·3 per cent. (Wale)

soon settles down leaving a swollen tender kidney with some fever as the only indication. In the more serious types things go from bad to worse until the patient presents the picture of acute ascending pyelonephritis. Sometimes drainage of the kidney pelvis may be life-saving. In his anxiety and apprehension about these special conditions the surgeon must not forget that these patients are liable to the occasional complications attending on laparotomy for any purpose—intestinal obstructions and burst wounds are not unknown.

**MORTALITY.**—The mortality rate depends to a considerable extent on the condition demanding the operation. In the non malignant cases and especially the congenital deformities it should be very low—perhaps 5 per cent. or less—but in the malignant cases such a low rate is not to be expected if the possible advantages of the operation are to be offered to the greatest number of sufferers. In this type of case it seems justifiable to hope that the mortality may be kept down to about 10 per cent. though the second stage of the operation for the removal of the bladder may add considerably to this figure. In children some deaths have been due to chest complications and to the exanthemata and the wisdom of choosing the summer months for the ordeal and of keeping children in hospital for a fortnight before operation should be stressed.

**WHEN TO TRANSPLANT THE SECOND URETER.**—When the two stage method is employed there is no stated time for dealing with the second ureter and the interval must depend on the progress made after the first intervention. If all goes well three weeks has proved a proper interval. Should it be otherwise the surgeon must bide his time. The only error is to intervene too soon. In the actual intervention the original incision is re-opened. There may be a few adhesions but they are not likely to be troublesome. The site of the first anastomosis will be securely sealed off and should not be interfered with.

**SOME LATE SEQUELÆ.**—Recurring renal infection, calculus and rectal incontinence are the special sequelæ. Intestinal obstruction and incisional hernia are no more frequent than after abdominal operations of similar magnitude.

**Special groups of cases.—CONGENITAL ANOMALIES.**—Of these the commonest is ectopia vesicæ which is said to occur once in every fifty thousand births. The next are the lesser degrees of the same condition such as complete epispadias in the male and the corresponding anomaly in the female known as subsymphyseal epispadias. In this group the age at which to operate is an important problem. The optimum time will occur somewhere between four and six but it is not so much a question of the number of years as of the condition and whatever the age the operation must not be carried out until the child is in established good health. Many a child at four is better fitted for the operation than others at six. But it is never too late to consider operation if congenital deformity is the indication and cases have been successfully dealt with at fifty. As a rule children do better than adults and it is surprising how readily they accommodate themselves to the altered physiological condition. In this group cases occur with weakness of the anus or even incontinence and occasional prolapse. If one of these states is associated with some degree of spina bifida and perhaps weakness of the lower limbs no improvement can be expected and transplantation into the usual site is contraindicated.

Male patients often have inguinal hernia but this is not a contraindication and radical cure can be carried out after successful transplantation. In the actual conduct of the operation in young children the surgeon may be reminded that in complete ectopia there is no umbilicus and that the linea alba is as wide as the separation of the pubic bones. In the abdomen the

parts are naturally small and delicate and suitable fine instruments must be available. Otherwise there is no essential difference from adults. In ectopia the exposed mucous membrane of the bladder is a distinct danger for many examples of the subsequent development of epithelioma in adult life have been recorded. Quite apart from this risk it is offensive to the eye, may give rise to an unpleasant discharge and is liable to mild injury and excoriation. In either sex the bladder should be removed when the health is properly stabilized after successful transplantation probably a year later. This should be combined with some sort of plastic repair of the *mons veneris* in females and the penis in males.

*Marriage*—With the lesser anomalies the question of marriage is often raised and even in complete ectopia patients of either sex have sought the consolation of matrimony. The female with a normal partner may prove fruitful and there is no reason why such marriages should not be happy. There appears to be no special risk in pregnancy and since the pubes are separated labour is often easy. In the male sexual gratification is said to occur. Now that the transplantation is less likely to be attended by troublesome sequelæ surgeons should welcome the opportunity of carrying out more careful and complete restoration of the genitalia.

*Separation of the pubic bones*—In the case of complete ectopia the symphysis is separated but the pubic bones are connected by a very strong ligament. In adults this separation may be to the extent of from 4 to 6 in. It is often assumed that such a degree of separation will result in marked disability, but though the upper part of the thighs are more or less widely separated and the patient walks with a characteristic gait the victims are usually quite strong and able to carry out ordinary activities without impediment. Attempts at approximation by operative measures have not been successful.

**MALIGNANT DISEASE OF THE BLADDER**—When this is the indication the management of the lesion cannot be divorced from the transplantation. In some cases it may be necessary to verify the exact extent of the growth before proceeding to the transplantation. Exploration by palpation through the wall of the lax bladder can be carried out through the mid line incision before opening the peritoneum. For this purpose it is necessary to have the bladder emptied by catheter on the operating table. The incision is made from umbilicus to pubes and is deepened in its lower two thirds down to the extra peritoneal tissue. By a little blunt finger dissection the bladder is exposed and being empty it is easy to determine by palpation through its wall the position, size and the degree of fixity of the growth without opening into the lumen. If it is decided to proceed the condition of the lymph nodes may be ascertained from within the peritoneum. Even if the growth is not suitable for subsequent extirpation it may be decided to transplant the ureters to provide physiological rest for an irritable and progressive lesion. When carrying out the transplantation in these cases there may be some unexpected dilatation of the ureters or some *perureteritis* as a result the ureter may be rather thick and rigid and glued to its bed. Such a ureter is friable and must be very gently handled. The bed for the ureter in the bowel wall must be made sufficiently roomy so that the ureter may be laid in and oversewn without risk of compression.

The disposition of the ureters may be a matter of moment. It is probably best to implant them both in one side of the bowel the left being placed an inch or so higher than the right. This necessitates bringing the left ureter across to the right behind the mesosigmoid unless indeed it can be readily exposed on the right of that structure. If the double implantation is made

into one side then the bowel should be anchored to the pelvic wall as mentioned in the description of the standard technique. On the other hand if the ureters are transplanted on opposite sides the bowel should not be anchored lest the fixation of one side may produce an undue strain on the opposite transplantation in varied distension or movement of the bowel. If there is any question of the integrity or security of the implantation or marked inflammatory change which might be followed by thrombosis and necrosis a rubber tube should be brought from the neighbourhood of the union and out through the lower end of the abdominal incision or through an independent small incision in one or other iliac fossa. This may be the means of preventing a fatality from peritonitis.

Special care should be taken with the suture of the abdominal wall as in victims of malignant disease these incisions have not infrequently given way. A very careful watch must be kept on the renal output though in cases with vigorous uresis before operation there will probably be no anxiety. It is probably safer to give continuous intravenous saline from the outset and if at the end of six hours there is no uresis then the sodium sulphate solution should be substituted. As soon as the patient can drink without discomfort he should be encouraged to do so. Hot tea, lemon water or well diluted whisky are efficient and safe diuretics. If after some days the patient has a frequent desire to void urine per penam or there is suprapubic distension and tenderness or pyrexia not otherwise explained a catheter should be passed and if necessary the bladder irrigated. The actual excision of the bladder should not be undertaken until the patient has made a complete recovery from the transplantation. It should not be sooner than a month or longer than three and the patient should always be well enough to be up and about for a few days before it is undertaken.

IN VESICOVAGINAL FISTULA there have usually been many attempts at repair with risk of infection and patients are often morbid as the result of grave disappointment. Much care must therefore be taken in the preparation of the patient. Should the condition be a ureterovaginal communication only the one ureter need be transplanted.

IN SYSTOLIC BLANDER following nephrectomy for tubercle it is essential to be sure that there is no active tuberculosis in the urinary tract. These patients are often worn out by their distressing condition and a rest in hospital before operation and a long convalescence afterwards under the most favourable conditions that can be provided will help the maximum benefit to be obtained.

G. GREY TURNER

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## CHAPTER XVIII

### THE SURGICAL ANATOMY OF THE BLADDER AND THE PHYSIOLOGY OF MICTURITION

#### THE SURGICAL ANATOMY OF THE BLADDER

**T**HE bladder is a muscular sac which is perforated inferiorly by the urethra through which it expels urine intermittently and inferolaterally by the two ureters through which it receives urine. It is lined by mucous membrane with a transitional epithelium continuous at their respective orifices with that of the two ureters and the urethra.

#### ATTACHMENTS AND RELATIONS

The inferior part of the bladder round the internal urethral orifice is immovably fixed to the base of the prostate in the male. Since the prostate is capable of only a small amount of anteroposterior movement the position of the internal urethral orifice remains nearly constant in all stages of distension of the bladder.

The fixation of the bladder depends chiefly on its fixation to the prostate and on certain thickenings of the pelvic fascia which secure both it and the prostate to the walls of the pelvic cavity. It is held to a slight extent by the reflection of the peritoneum and by the urachus. The urachus is a fibrous cord attached below to the anterior surface of the bladder just below its apex which extends up to the umbilicus under the peritoneum and makes a median ridge on the posterior aspect of the anterior abdominal wall.

Before describing the important fascial structures which fix the bladder and prostate it is well to deal with a part of the pelvic fascia which does not. If the posterior surface of the prostate is approached from the perineum by dividing the recto urethralis muscle which fixes the membranous urethra to the anterior wall of the rectum the finger enters a layer of areolar fascia between the prostate and the rectum. This is Denonvilliers' fascia. Separation of the rectum behind from the prostate vesiculæ and posterior border of the bladder in front in this loose fascia offers no resistance to the finger and causes no bleeding. This separation can however only be carried out in a more or less coronal plane and the finger cannot be passed forwards between the side of the prostate and the pelvic wall. If this is attempted at the level of the upper part of the prostate and base of the bladder a hard thick object is felt extending laterally to the side of the pelvis. This is the posterior border of the lateral true ligament of the bladder. It is therefore evident that there is no firm fixation of the posterior part of the bladder but rather that the connective tissue between it and the prostate in front and the rectum behind is so loose as to make movement between them easy when changes in distension of the rectum or bladder occur.

The fascia which fixes the bladder consists of two parts the thickened fascia surrounding the prostatic and vesical venous plexuses (perivascular fascia) and the fascia covering the internal surface of the levator ani (visceral

pelvic fascia) The fixation is brought about by the fact that the perivascular fascia is continuous centrally with the wall of the inferior part of the bladder and the superior part of the prostatic sheath and peripherally with the peritoneum of the posterior surface of the pubis and the visceral pelvic fascia lateral to it The thickenings of the parts of the perivascular fascia which are continuous in this way are called the anterior (pubo prostatic) and lateral true ligaments of the bladder These ligaments and the fixation of the membranous urethra to the triangular ligament are all that firmly fix the bladder and prostate As the anterior and lateral true ligaments are fixed to both the prostate and base of the bladder they exclude the possibility of torsion both of the bladder round its own neck and of the bladder and prostate round the membranous urethra

The anterior true ligaments of the bladder contain a large amount of plain muscle besides fibrous tissue Medially they have well defined borders which are separated by a narrow space across which the ligaments are continuous only by thin areolar tissue Laterally they pass into the lateral true ligaments from which they are not clearly separated Anteriorly they are attached to the posterior surface of the pubis below its middle Posteriorly they blend with the anterior muscular commissure and fascial sheath of the prostate and with the adjoining part of the bladder wall

The lateral true ligaments of the bladder are thicker than the anterior true ligaments They are fixed medially to the sides of the base of the bladder as far back as its perforation by the ureters but no further and to the adjoining part of the prostatic sheath Laterally the lateral true ligaments are attached to the white line (arcus tendineus) which is a thickening in the visceral pelvic fascia extending from the posterior surface of the pubis backwards to the ischial spine on the medial side of the uppermost part of the levator ani and behind this to the fascia covering the pyriformis and to the front of the sacrum

The sheath of the prostate below the attachment of the ligaments is formed by the parts of the visceral pelvic fascia intervening between the sides of the prostate and the levator ani These become continuous with each other on the posterior surface of the prostate and limit Denonvilliers' fascia anteriorly Below the sheath of the prostate becomes continuous with the triangular ligament

In the female the inferior surface of the urethra and part of the bladder immediately behind the urethral orifice are fixed to the anterior wall of the vagina and behind and above this to the anterior surface of the cervix The attached area is greater than in the male extending well behind the ureteric orifices On the other hand the structures to which the bladder is attached are less fixed than in the prostate The anterior and lateral true ligaments of the bladder have the same arrangement as in the male except that the perivascular fascia surrounds the vesical vaginal and uterine veins their medial attachment is therefore to the same part of the bladder and to the adjoining parts of the vagina and cervix

The bladder acquires some fixation from the reflection of the peritoneum In the male with the bladder empty the peritoneum passes from the anterior abdominal wall and sides of the pelvis on to the superior surface of the bladder the whole of which it covers Posteriorly in the mesal plane the peritoneum passes round the posterior border of the superior surface either on to the anterior surface of the rectum or on to the lower parts of the vasa where these are contiguous and from them on to the anterior surface of the rectum The reflection here forms the bottom of the rectovesical pouch of peritoneum On



either side of the mesial plane the peritoneum passes off the superior surface of the bladder on to the inferior part of the vas and immediately lateral to this on to the superior part of the vesicula seminalis. More laterally still it becomes continuous with the parietal peritoneum on the side of the pelvis as already stated.

The reflection of the peritoneum from the anterior abdominal wall on to the superior surface of the empty bladder of an adult is commonly slightly behind and below the superior border of the symphysis pubis in a dead body. During life with each respiration there is a considerable differential movement in a vertical direction between the bladder with the attached peritoneal reflection behind and the fascia transversalis in front. Because of the relative absence of fat this is more easily seen in a child than in an adult. It follows that in a living person the peritoneal reflection in the mesial plane anteriorly cannot be regarded as a fixed point. During operations a force which is inappreciable may displace it considerably. In consequence on the one hand it is easy to do a suprapubic cystostomy when the bladder is empty unless it has been dragged downwards by perivesical disease while on the other the bladder may be accidentally opened if an incision of the peritoneum is continued down to the symphysis. The fascia transversalis close above the pubes is a well marked sheet which commonly has fat on both sides of it and lies between the linea alba in front and the peritoneum and below the reflection the anterior wall of the bladder behind. It is attached below to the bodies of the pubes immediately above the anterior true ligaments of the bladder. A potential space filled with loose fat is thus formed between the fascia transversalis and the anterior wall of the bladder. This is the prevesical or Retzius space. Into it urine extravasates after a rupture of the posterior urethra or of an extraperitoneal part of the bladder. The spread of the urine downwards is prevented by the triangular ligament so it occurs upwards on the deep side of the anterior abdominal wall.

At the reflection of the peritoneum from either side of the superior surface of the bladder on to the pelvic wall in front there is a shallow depression called the paravesical fossa. The bottom of the paravesical fossa is medial to the obliterated hypogastric (umbilical) artery and to the vas deferens. A transverse ridge the plica vesicalis transversa formed by reduplication of the peritoneum extends from the superior surface of the bladder on to the paravesical fossa in the direction of the internal abdominal ring on either side. A broader ridge the sacro genital fold projects backwards from the posterior border of the bladder. It has a sharp crescentic edge posteriorly forms the upper limit of the rectovesical pouch and contains parts of the vasa between its two layers.

As the bladder becomes full it enlarges upwards outwards and backwards with the following results. (1) The peritoneal reflection in front is carried upwards behind the fascia transversalis so that a considerable part of the abdominal wall close above the symphysis pubis is not covered by peritoneum. (2) The summit of the bladder rises above the level of the peritoneal reflection so that above the peritoneal reflection part of the bladder covered by its peritoneum is in contact with the parietal peritoneum of the anterior abdominal wall. (3) The peritoneum on the sides of the pelvis is taken up on to the sides of the bladder obliterating the paravesical fossae and bringing the sides of the bladder into contact with the obliterated hypogastric arteries. (4) In the narrow space between the inferior parts of the vasa the peritoneum is reflected from the posterior border of the superior surface of the bladder directly on to the anterior surface of the rectum. Therefore with filling the

peritoneal reflection is considerably raised in front and at the sides but hardly at all posteriorly

The peritoneal relations of the bladder in the female differ from those in the male in that the peritoneum on its superior surface is reflected on to the anterior surface of the uterus at the junction of the cervix with the body and in that the sacrogenital fold is attached anteriorly to the posterior surface of the uterus and does not reach the bladder. A peritoneal recess the uterovesical pouch is present between the body of the uterus and the superior surface of the bladder. An important consequence of the difference in the peritoneal relations of the bladder in the two sexes is that the pelvic colon is in contact with the posterior part of the superior surface of the bladder in the male whereas the uterus and vagina intervene in the female. A pericolic abscess arising from disease of the pelvic colon can therefore perforate the bladder usually far back behind the trigone on the left side in the male but not in the female.

### BLADDER MUSCLE

The muscular coat of the bladder (Ellis 1806) consists of three layers (1) external (longitudinal) (2) middle (circular) and (3) internal (longitudinal or submucous). There is a considerable interchange of bundles between the three layers so that they cannot be separated completely from each other without cutting through muscular bundles.

The external layer consists of longitudinal bundles passing from the apex to the base and is best marked below and in front. Above the fibres are inserted into the peritoneum covering the superior surface and some are prolonged into the urachus. Below the fibres in front are partly attached to the back of the pubes by the anterior true ligaments of the bladder and partly continued over the sides and anterior surface of the prostate to end in its sheath. Below and behind the fibres pass into those of the deeper layer and of the prostate. In the female they reach the fascia over the vagina.

The middle layer is thickest towards the neck of the bladder where it forms a ring which communicates extensively with the other two layers. At the urethral opening it becomes continuous with the muscle of the prostate or in the female the circular bundles surrounding this part of the urethra.

The internal layer is thinner and less complete than the other two. In the lower part of the bladder the bundles are longitudinal higher up they are thin and irregular in direction. At the urethral opening this layer becomes continuous with the submucous layer of the urethra. The ureters pierce the outer and middle coats of the muscle of the bladder. Most of the fibres of the ureteric muscle pass medially to unite with those of the opposite side the remaining part of the ureteric muscle joins the internal layer of the bladder muscle and passes obliquely downwards deep to the mucous membrane of the trigone to the submucous layer of the urethra.

### INTERIOR OF THE BLADDER

The interior of the bladder varies greatly in shape and in the appearance of its walls according to the degree of distension except in a small region below which is related to the three orifices. This region is called the trigone. It is the shape of a nearly equilateral triangle with each of its sides concave outwards. The trigone is developed from mesoderm whereas the rest of the bladder is developed from the endoderm of the cloaca. It is more conspicuous in the male than in the female. Its posterior side is best defined and is formed

by the interureteric bar a smooth transverse ridge at or near the ends of which the ureteric orifices are situated. The two remaining sides which are often asymmetrical curve forwards and inwards from the ends of the interureteric bar to the posterior edge of the internal meatus. The trigone is slightly raised above the neighbouring parts of the interior of the bladder its surface is smooth in all degrees of distension of the bladder and its area increases little if at all with increasing distension of the bladder. In the adult male the trigone in front of the interureteric bar is red the colour is due to numerous closely set small vessels in the mucous membrane which run antero posteriorly.

The rest of the interior of the bladder appears nearly white with widely scattered small red tufts of vessels. These vessels increase in number and size if fluid introduced into the bladder is too warm if retention of urine has just been relieved and also in many diseases of the bladder. In a moderately distended bladder the interior is smooth unless the bladder is in a state of contraction when smooth ridges formed by the contracted fasciculi appear running in various directions and leaving depressions between them. If the wall of the bladder is hypertrophied from having contracted against an obstruction of long duration the ridges and depressions are permanent and remain after death the ridges are then called trabeculae and the depressions when large enough sacculi. Whether or not hypertrophy is present the ridges and depressions are most marked near the posterior angles or horns of the trigone.

In a nearly empty bladder ridges of another kind called rugae appear. The mucous membrane of the bladder is less resilient than the muscle therefore with every volume alteration one must move on the other. This sliding movement takes place on a layer of loose connective tissue which separates the muscle from the mucous membrane everywhere except on the trigone. As the volume of the bladder diminishes a stage is reached when the mucous membrane can no longer shrink to the area of the muscular layer on which it rests it can then only accommodate itself to this area by forming folds these are the rugae and they consist of reduplications of mucous membrane only. Rugae have little resemblance to trabeculae they are thicker and tend to be parallel and transversely disposed. Rugae are most conspicuous in the posterior part of the bladder from behind the trigone backwards. When part of the mucous membrane has become less resilient from disease such as some forms of cystitis the rugae may remain in this part when the bladder is moderately distended they have been mistaken for growths.

The shape of the bladder in a living subject is best ascertained by the shape of its interior as found by radiography when the bladder contains some radio opaque substance (Lichtenberg and Volcker 1905 Hryntschak and Sgalitzer 1922). As the shape alters greatly with contraction of the bladder it is better that the radio opaque substance should be given intravenously rather than intravesically. It is found that the shape of a partly filled resting bladder varies with the position of the subject from the action of gravity on its contents and on the surrounding viscera. With a low distension the superior surface is concave or flat and the shape that of an obtuse angled triangle with the obtuse angle below in a lateral view the posterior part of the triangle is the shorter and the anterior part rises well above the pubes. The transverse diameter is considerably greater in women than in the men. With increasing distension the inferior angle becomes less obtuse and becomes greatly diminished and the shape rounded with the vertical diameter slightly greater than the transverse this shape is permanent in diseases which lead to constant contraction of the bladder such as cystitis.

## THE BLADDER IN CHILDREN

In a new born child the bladder is pear shaped with the narrow end downwards and the internal meatus at its lowest part. There is no floor to the bladder for the trigone is situated nearly vertically and is only slightly differentiated from the surrounding mucous membrane. When empty the bladder is flattened from before backwards. The trigone remains in the upright position in children and only becomes oblique shortly before puberty.

At birth the peritoneum covers part of the posterior surface of the prostate this covering disappears in a few months and by two years the reflection has risen to the level of the ureteric openings its usual level in adults.

At birth the urachus corresponds to the apex of the bladder. Later at any rate by two and a half years the urachus is attached to the anterior wall but rises to the highest point again as the bladder fills. There is a triangular area with its base on the pubes and its apex upwards which is free from peritoneum and where the bladder lies against the anterior abdominal wall. With the bladder empty this area is about  $2\frac{1}{2}$  cm. vertically it increases as the bladder fills and diminishes with age as the bladder sinks into the pelvis.

## VESSELS AND NERVES

The bladder is supplied by two pairs of arteries which are branches of the anterior division of the internal iliac (hypogastric) artery. The superior vesical artery is at its origin part of the hypogastric (umbilical) artery which has not become obliterated at birth. It crosses in front of the ureter from without inwards and arrives at the side of the bladder where it divides into branches which are distributed to the upper part of the bladder. The superior vesical artery is not surrounded by any special thickening of the pelvic fascia so that there is no fixation of the part of the bladder with which it first comes in contact to the side of the pelvis. The branches of the superior vesical artery anastomose with those of the artery of the opposite side and with those of the inferior vesical artery. The inferior vesical artery passes downwards from its origin and reaches the base of the bladder in the lateral true ligament. It supplies the inferior part of the bladder, the prostate and vesicula and its branches anastomose with those of the superior vesical and middle hemorrhoidal arteries. In the female the vaginal artery takes the place of the inferior vesical. It sometimes arises from the uterine.

The veins of the bladder ultimately open into the internal iliac veins but their course is complicated by their connections with venous plexuses of other pelvic organs. These plexuses are of surgical importance because in adults they are commonly the seat of phlebotiths (calculated clots) which were shown by Fenwick and Kidd (1908) to be the cause of small shadows found in radiograms of the pelvis and sometimes mistaken for those of ureteric stones.

The veins of the pelvic plexuses are well provided with valves but to find these it is necessary to examine children or young adults as in later life many disappear and then the veins become dilated (Fenwick 1885). The dorsal vein of the penis which is valved passes under the subpubic ligament and then divides into two. Each branch usually communicates with the internal pubic vein and then passes along the side of the prostate where it forms with the veins of the prostate and other tributaries the vesico-prostatic plexus (labyrinth of Santorini). As these veins travel backwards

they receive the veins from the base of the bladder and finally empty into the internal iliac veins. Valves are present in all parts of the vesico prostatic plexus from its beginning at the pubic arch to its end in the internal iliac vein. The only veins from the bladder which enter the vesico prostatic plexus and are not valved are those from the inferior part of its anterior surface. A vertical vein begins on the subperitoneal surface of the bladder runs downwards and forwards in the middle line of the upper two thirds of the bladder bifurcates and either branch opens posteriorly into the vesico prostatic plexus. The veins of the lateral posterior and inferior parts of the bladder open into the posterior part of the vesico prostatic plexus and are valved.

The lymphatics of the bladder drain chiefly into glands which lie along the posterior part of the external iliac vein and into others which lie along the internal iliac vessels.

The nerves of the bladder arise from the spinal cord in two groups of spinal roots which are separated from one another a lumbar group passing to its distribution by the sympathetic and a sacral group (see p 228). The sacral nerves are the more important because their division on both sides leads to disorganization of micturition this accident sometimes occurs in excision of the rectum. The branches of the sacral nerves to the pelvic viscera arise from the anterior aspects of the third and fourth and sometimes of the second sacral nerves. They pass forwards round the sides of the rectum towards the base of the bladder in the inferior part of its lateral true ligament. Just before reaching the bladder they break up and form a dense plexus the pelvic plexus in which they are joined by the fibres of the hypogastric plexus from the lumbar roots. The branches of the pelvic plexus are distributed to the bladder and other pelvic viscera.

The branches from the lumbar roots (sympathetic) pass into the pelvis in front of the common iliac artery close to its origin. The nerves of the two sides split up and anastomose in front of the fifth lumbar vertebra forming the hypogastric plexus. The hypogastric plexus divides into a right and left half each of which passes downwards to join the corresponding pelvic plexus.

## THE PHYSIOLOGY OF MICTURITION

### RESIDUAL URINE

The urinary bladder in mammals is a muscular reservoir whose only function is to retain urine for longer or shorter periods and to expel it at intervals the act of expulsion is called micturition. The obvious advantage of this arrangement is that the mammal smells of its own urine to a less extent than it would if urine leaked away at its own secretion rate and therefore is less likely to be detected by its foes if herbivorous or by its prey if carnivorous. The function of storing water for the use of the animal which is present in the bladder of amphibians is absent in mammals.

Micturition in man normally leads to emptying of the bladder. Urine left in the bladder after micturition is called residual urine. Apart from voluntary interruption of micturition residual urine may occur in a healthy man if he has held urine so long after the desire to pass it has arisen that the bladder muscle has become fatigued from overstretching. If micturition is attempted in an unusual position such as lying on the back if no desire to pass urine is experienced at the time it is passed or if the rectum is full and defecation does not occur at the same time as micturition. In otherwise normal subjects residual urine can occur under the influence of certain drugs.

the most important of which is alcohol or if a condition is present which is calculated to make micturition painful such as piles or recent surgical operations particularly on the abdomen or perineum. In practice it is therefore important to see that none of these conditions is present if diagnostic significance is to be attributed to a found volume of residual urine to see that all patients about to have the kind of operations mentioned can pass urine lying down before the operation is done and as far as possible to abstain from confining patients to bed if they have or may have some potential mechanical interference with micturition particularly senile enlargement of the prostate. Neglect of the last precaution often leads to retention of urine in cases of senile enlargement of the prostate which would not have got it at any rate at the time had they been left to themselves.

In some mammals such as male dogs and cats small amounts of urine are often passed when it is obvious that the need for micturition cannot have arisen since attempts to urinate often fail because all the urine has been passed just before at such times it is often evident that the bladder is not emptied when the urine is passed since the amounts of urine passed are greater than could be accounted for by the secretion of urine in the intervals. The habit of passing urine in this way has probably some sexual purpose in cats the behaviour before passing urine in this way and before true micturition is quite different. The importance of the habit in the physiology of micturition is that it shows that cats and dogs like men can pass urine and interrupt the act voluntarily even when no need for micturition exists.

### THE CLOSING MECHANISM OF THE URETHRA

Between two acts of micturition urine is held at the internal urinary meatus by the posterior urethra which is the membranous and prostatic portions of topographical anatomy and the homologue of the whole female urethra (Griffiths 1895 Rehfisch 1897). The means the posterior urethra has of retaining urine consists of a series of smooth muscle fibres forming a circular layer round it and the compressor urethræ which is a striped muscle surrounding the membranous or distal part of the posterior urethra.

The smooth muscle fibres are often called the internal sphincter of the bladder and the compressor urethræ the external these are convenient terms provided it is realized that the smooth muscle fibres are not collected together into a compact ring at a particular level and therefore anatomically do not form a sphincter. In the intervals between micturitions the whole posterior urethra is closed even when an urge to micturate is present. This can be shown either by radiograms when the bladder is full of some inert radio opaque liquid or by passing a catheter with a terminal opening when it is found that urine does not flow until the end has passed the prostatic urethra. Although urine is held at the internal meatus the compressor urethræ is more strongly closed than the smooth circular muscle which is nearer to the internal meatus. This has been shown directly in dogs (Courtade and Guyon 1895) and in man is evident from the sensation experienced by the operator in passing a catheter on a normal male when the chief resistance felt is at the level of the compressor urethræ.

It is probable that sudden straining movements such as sneezing by leading to a considerable transitory increase in intravesical pressure cause a rapid entrance of urine into the posterior urethra followed by an immediate retreat since such movements cause slight incontinence in some patients who have had mechanical damage to the perineal muscles and in some cats

who have had the compressor urethræ paralysed by division of the pudic nerves although in neither case is there incontinence in other circumstances

Surgical observations show that urine can still be held if either the internal or external sphincter is destroyed and the other remains intact but not if both are destroyed. The external sphincter must often be divided in external urethrotomy and incontinence does not result unless the prostatic urethra has previously been destroyed by prostatic suppuration. After suprapubic prostatectomy the prostatic urethra is destroyed down to the verumontanum and the cavity left above this which takes the place of the prostatic urethra is always full of urine (Walker 1906) and yet incontinence does not follow. Suprapubic removal of stones from the prostatic cavity occurring after suprapubic prostatectomy is not followed by incontinence but perineal removal usually is and this approach is likely to involve the compressor urethræ.

After nervous lesions which interfere with the reflex contraction of the bladder the posterior urethra remains full of urine which is held at the level of the compressor urethræ. This can be shown by radiography and by the fact that the verumontanum is easily visible on ordinary cystoscopy when the patient is under no anæsthetic and has no strong desire to micturate.

The internal sphincter like other smooth muscle receives its efferent nerves from two sources the hypogastric nerves which arise from the lumbar roots and are part of the sympathetic system and the pelvic nerves (nervi erigentes of Eckhard) which arise from the sacral roots. Stimulation of the peripheral cut end of the hypogastric nerve causes contraction of the urethra (Zeissl 1893 Elliott 1907) but division of both hypogastric nerves does not lead to gaping of the internal meatus or filling of the posterior urethra with urine. Stimulation of the peripheral cut end of the pelvic nerve leads to relaxation of the urethra. The compressor urethræ being a striped muscle is supplied by a somatic nerve this nerve is a branch of the dorsal nerve which is a branch of the pudic nerve which arises from the sacral plexus. Division of both pudic nerves in cats produces a slight degree of incontinence but this generally only amounts to the escape of a few drops when any strong straining movement is made and sometimes only to the escape of urine if the bladder is gently squeezed through the abdominal wall (Barrington 1914).

### THE PERIPHERAL NERVES OF THE BLADDER

The bladder receives all its efferent nerve fibres from the same two pairs of nerves as supply the smooth muscle of the urethra namely the hypogastric and the pelvic (Budge 1858 Giannuzzi 1863 Langley and Anderson 1895). The hypogastric nerve arises from the lumbar spinal roots and the pelvic nerve from the sacral the particular roots vary in different mammalian species and to a lesser extent in different individuals of the same species but in every individual of every species of mammal on which the observation has been made spinal roots which contain no bladder fibres intervene between the two sets which do (Sherrington 1892 Langley and Anderson 1895). Each efferent nerve fibre to the bladder has a nerve cell on some part of its course after it has left the spinal cord. Both hypogastric and pelvic nerves contain afferent as well as efferent fibres. This fact by itself does not show that these come from the bladder since both nerves supply other organs as well but the paths of bladder reflexes show that they do. The afferent fibres pass to the cord in the dorsal spinal roots.

Stimulation of the peripheral cut ends of the hypogastric nerves produces rather different effects in different mammals (Elliott 1907). The bladder

base contracts but in some species such as the cat the rest of the bladder relaxes to such an extent that the bladder volume increases (Stewart 1899) and this is probably so in man (Icarmonth 1931)

Division of both hypogastric nerves in dogs does not interfere with the performance of micturition (Mosso and Pellicani 1882) it is now well known that the same is true in man. In the cat it only produces a slight degree of frequency of micturition (Barrington 1915)

Since the hypogastric nerves seem to have almost nothing to do with micturition it may seem remarkable that they supply the bladder and urethra at all. They are the efferent nerves of the internal male genital organs through them the vasa and vesiculae contract and expel their contents—a fact that surgeons who divide them sometimes seem to ignore—and through them the prostate and Cowper's glands secrete. Since urine and the male genital products pass down the same passage it is not unlikely that the action of the hypogastric nerves on the bladder and urethra is concerned with preventing the escape of urine from interfering with emission rather than with micturition.

Stimulation of the peripheral cut end of one pelvic nerve produces a strong contraction of the corresponding half of the bladder in all mammals in which the experiment has been done.

Division of both pelvic nerves but not of one completely disorganizes micturition (Lannegrace 1892). In cats division of both pelvic nerves is followed by complete retention of urine until the bladder becomes overdistended and overflows giving rise to unconscious incontinence. The overdistension may produce haematuria but there are no signs of pain even when the bladder is gently compressed through the abdominal wall. After some days the cats cease to drip urine at all times and deliberately squat and pass small amounts of urine at frequent intervals remaining dry during the intervals. There is always a large volume of residual urine and the urethral resistance is great. If the pudic nerves are now divided the residual urine becomes rather less the urethral resistance greatly diminishes and unconscious incontinence reappears as shown by the fact that the urine again drips away continuously and the cats cease to squat to pass it (Barrington 1915). It follows that the pelvic nerves are both the motor nerves to the bladder and the conductors of the afferent impulses which give rise to the pain and distress of retention of urine. The sensation remaining after division of the pelvic nerves which passes by the pudic nerves must arise in the urethra and be so unlike that of a normal desire to micturate that it takes the cats some days to learn what it means.

Conditions clinically resembling division of both pelvic nerves in other mammals sometimes follow excision of the rectum in man and this operation is likely to involve them. The fact that some such cases recover after weeks or even months can be explained by assuming that both nerves have been damaged at the operation but that at least one has not been divided completely.

In pathological conditions of the bladder which greatly increase its irritability such as tuberculosis there is often clinical evidence of the existence of a sensation evoked by distension of the bladder whose impulses do not pass through the sacral roots. If a cystoscopy is done on such a case under a spinal anaesthetic which has given complete analgesia of all the sacral dermatomes irrigation of the bladder produces no strangury or any sensation which the patient recognizes as anything to do with a desire to micturate but he will experience a pricking or burning sensation over or just above the pulses when



too large a volume of lotion is put in the bladder. In the same patient lotion at a constant temperature injected at the same rate will produce the sensation repeatedly at a constant volume. The sensation goes immediately the lotion is released while that of strangury does not. An irritating lotion injected after an inert one produces the sensation with a smaller volume but only after a considerable latent period which is not present with the inert lotion. This sensation can be evoked when the upper limit of the analgesia is 1 cm. below Poupart's ligament but not if it is 2 cm. above the pubis. It therefore seems that the highest root which carries its impulses is either the eleventh or twelfth thoracic. There is nothing to show whether they pass through the hypogastric nerves or through nerves to the coverings of the bladder.

### DIVISION OF THE DORSAL SPINAL ROOTS IN THE SACRAL REGION

Division of the dorsal roots of the sacral spinal nerves in dogs and cats leads to retention of urine with overflow (Meyrbacher 1902; Barrington 1914). The animal shows no sign of distress such as would accompany retention of urine in an intact animal and pressure on the bladder through the abdominal wall does not produce any unless it is great enough to produce it by action on the abdominal wall itself. The urethral resistance to the expression of urine is very great and unlike that after section of the pelvic nerves does not suddenly give way while the pressure in the bladder is being maintained. Overdistension of the rectum occurs as well as the effect on the bladder but erections still take place normally. These effects are permanent and are unaltered by division of the hypogastric nerves. The afferent impulses essential for micturition and those which give rise to the pain of retention of urine therefore all travel by the sacral dorsal roots.

### DIVISION OF THE CAUDA EQUINA

Division of the cauda equina leads to a distended bladder which overflows at a low urethral resistance (Masius 1868) in the same way as that of a cat with both pelvic and pudic nerves divided. The bladder shows small rhythmic contractions which are not markedly altered by increases in pressure after they have once started whereas those following a spinal transection are, these contractions may be seen at once but they are more obvious after some days or weeks. In cats besides these small alterations in tone larger ones occur at much longer intervals after the lesion has existed for months. In these the residual urine having been more or less constant for days or weeks suddenly either increases or decreases possibly as much as tenfold and remains more or less constant at the new volume for days or weeks. If the change is an increase the cat may remain dry for a day or more until the bladder begins to overflow at the increased volume while if the change is a decrease urine may be passed in a continuous though weak stream for minutes. The causes of this alteration are unknown.

After complete cauda equina lesions in man retrograde cystograms show that at least commonly the prostatic urethra remains open (Watkins 1936).

### TRANSECTION OF THE SPINAL CORD

The effects of a complete transverse lesion of the spinal cord on micturition have been investigated chiefly in dogs and cats (Goltz 1874; Barrington,

1914) but as far as knowledge goes they are essentially the same in other mammals, including man (Head and Riddoch 1917), particularly in man these effects are often modified, or masked by those of infection. The effects are the same whatever the level of the lesion, provided that this is not high enough to destroy life within the necessary period or low enough to involve the nuclei of the sacral roots concerned with micturition. They are therefore the same with the lesion at any level from the lowest cervical to the lowest lumbar segments inclusive, whether or not this level is between the sacral and sympathetic roots to the bladder or above both.

The immediate effect of spinal transection is to produce retention of urine which if left alone, goes on to overflow. In the course of a few days in a cat or a few weeks in man, the urine remaining uninfected this state is succeeded by a condition known as automatic micturition, but though the conditions at the beginning and the end appear quite different one condition passes gradually into the other and there is no sharp distinction between the two. The pressure at which the bladder overflows during the stage of retention is high enough to damage the bladder wall, and in this way haematuria is often produced even in the absence of infection.

If the escape of urine is watched during the overflow stage, it will be seen that it is not uniform but occurs in association with slight movements of the perineum, pressure on the bladder gives rise to an increase of the movements which are rhythmic, and an escape of urine with the same periodicity as the movements, with each escape the urethral resistance can be felt to lessen but it remains marked between each escape. In the early stages in a cat the bladder can seldom be emptied by abdominal pressure without an anaesthetic because although the bladder to some extent contracts down on to its remaining contents after some of the urine has been expressed, it still remains too lax to maintain the pressure necessary to empty it by further expression. If chloroform is given the palpable urethral resistance goes completely and the bladder can then be expressed until empty, but this only occurs if enough chloroform is given to stop respiration, the resistance abolished in this way only returns an appreciable time after spontaneous respiration has been re-established by means of artificial respiration (Barrington, 1931).

When automatic micturition has become established almost any kind of stimulus may evoke a series of perineal movements associated with the passage of jets of urine having the same periodicity, in this way movements of the unparalysed parts innervated by roots in front of the transection may indirectly produce the escape of urine by moving the paralysed parts. The most effective stimuli for exciting the passage of urine are touches to the perineal region or holding the cat in a vertical position, in either of these ways a series of jets of urine may be passed which together make up a large volume but there is always residual urine at the end.

Automatic micturition is unaffected by division of the hypogastric nerves either before or after it has commenced. Division of both pudic nerves at any stage abolishes all palpable urethral resistance and with it the reflex passage of urine in jets, the urine then drips away at a faster or slower rate according to the increase or diminution of intra abdominal pressure, which varies with the activity of the cat. Division of both pelvic nerves at the time of the transection prevents the occurrence of the diminution in the urethral resistance which would otherwise follow. Division of both pelvic nerves after automatic micturition has become established leads to a great increase in the urethral resistance which persists. The persistently high urethral resistance which follows a spinal transection combined with division of both pelvic nerves,

which its existence is assumed are less precise than those in the other reflexes

5 Distension of the bladder evokes relaxation of the urethra the afferent path being in the pelvic and the efferent in the pudic nerves

6 Distension of the bladder evokes opening of the posterior urethra chiefly in its proximal part, both paths being in the pelvic nerves

7 Running water through the urethra evokes contraction of the bladder both paths being in the pelvic nerves This reflex requires a stronger stimulus and gives a smaller effect than the second reflex

It is evident that if any one of these reflexes occurs, except perhaps the third and sixth, its own effect will bring all the remaining reflexes into action. The third reflex is the only one with a path in the sympathetic and its effect is trivial

The various reflexes are affected differently by transection of the spinal cord. The second is abolished permanently. The fifth and seventh can easily be obtained immediately after the transection. The sixth was only shown in cats which had a transection some time previously, so it is not known if it is obtainable immediately after the transection. The effect of the fourth reflex is more difficult to show immediately after the transection. Reflex contraction of the bladder evoked by distension cannot be obtained immediately after transection, but in the course of time it reappears though to a much smaller extent. It was at first believed (Barrington 1921) that this reflex contraction remained absent, but this conclusion was subsequently found to be erroneous. It is now certain that in the cat some degree of reflex contraction results from distension when automatic micturition has become established, Denny-Brown and Robertson (1933) have shown that this is true in man.

It is obvious that in many cases the activity of one of the reflexes will bring the others into action. Since the stimulus in the second reflex may just as well be the relaxation of the urethra as the pressure of water on the mucous membrane of the urethra it may well be that voluntary micturition arises from a voluntary relaxation of striped muscle which in its turn causes a reflex contraction of the bladder this is what appears to be probable from experience. If voluntary micturition is performed when a strong desire to micturate is present the events occur so quickly that the subject is unconscious of the order in which they occur. If however, voluntary micturition is performed when no desire to micturate is present the subject is conscious of the following sequence: relaxation of the perineum, the onset of a desire to micturate, and, finally micturition itself. This sequence of sensations suggests that voluntary micturition is brought about by volition acting on striped muscle. The fact that it can occur in the cat, and therefore probably in man, after section of the pudic nerves does not invalidate the supposition, because the perineal muscles act together and the levator ani receives other nerves.

The gradual passage of retention with overflow into automatic micturition after a spinal transection cannot be accounted for simply by the abolition of the second reflex because division of both pudic nerves does not lead to residual urine. There must be many factors in the causation of this phenomenon, and many of these may well be unknown, but the slight recovery of the first reflex and the greatly increased activity of the fifth, must play an important part in it, in the latter case it seems likely that in some way over distension of the bladder has made it permanently more irritable and therefore more ready to evoke the fifth reflex.

### LESIONS OF THE BRAIN STEM

After decerebration cats do not get either incontinence or retention. Urine is passed in a stream at intervals with little or no residual urine and finishes with perineal contractions. Micturition is as normal as it can be with a cat lying on its side—it occurs rather more frequently than normally but it is possible that this may be due to some condition of the experiment other than the absence of the part of the brain in front of the transection such as temperature alterations (Barrington 1921). The plane of decerebration goes through the superior colliculi on the dorsal side and the crura at the superficial origin of the third nerves on the ventral. The whole central nervous mechanism for the performance of micturition must therefore be contained in the part of the nervous system behind this plane. From this it seems that in the cat any influence that the parts of the brain in front of this plane may have on micturition must be confined to regulating the frequency with which it occurs in various circumstances.

By special methods small lesions can be made within the brain by electrolysis. By this means it is found that a small lesion on both sides of the brain of a cat just ventral to the internal edge of the superior cerebellar peduncle from the level of the middle of the motor nucleus of the fifth nerve behind to that of the posterior end of the aqueduct in front produces a permanent inability to empty the bladder. Bilateral lesions just in front of this level involving the ventral half of the posterior part of the aqueduct outwards to just beyond the mesencephalic root of the fifth nerve produce a permanent loss of consciousness of wanting to micturate and defæcate but do not otherwise impair either (Barrington 1925).

### LESIONS OF THE CEREBRAL CORTEX

Bochefontaine (1874) obtained contraction of the bladder by faradization of the outer part of the sigmoid gyrus of a curarized bitch just in front of the crucial sulcus. Many subsequent observers have obtained the same result by stimulation of various parts of the sigmoid gyrus of dogs and cats though the parts found effective have not been the same with all observers. On the other hand the celebrated bitch from which Goltz (1892) had removed both cerebral hemispheres in two operations and which was killed when healthy eighteen months later before defæcation used to make a number of quick circular movements and pass feces and urine in the same peculiar position as normal bitches. In cats also removal of the sigmoid gyri on both sides is not followed by any defect in micturition. Langworthy and Hesser (1936) found that removal of the motor cortex on both sides in cats leads to the bladder reacting to a smaller volume on artificial distension than previously and that this was not further diminished by subsequent decerebration.

Since removal of the motor cortex in dogs and cats produces at most only trivial and evanescent defects in gait and other voluntary limb movements the absence of any defect in micturition after the same lesions cannot be used to infer what occurs in man in the same circumstances. Foerster (1918) and Kleist (1918) made observations in cases of gunshot wounds of the skull. Kleist concluded that the cortical centre for the voluntary control of the bladder must lie near the leg centre because interference with emptying the bladder occurred in the absence of psychical disturbance only with bilateral paralysis of the feet and legs. There was involuntary incontinence in three cases and retention in one—the skull injury was close to the sagittal

suture Foerster concluded that interference with micturition only occurred with cortical lesions when the e were bilateral. At the outset the interference was bladder paralysis combined with sphincter spasm so that catheterization was necessary over a long period the defect passed off gradually but in many cases some weakness remained. Incontinence occurred but was rare. The bladder disturbance was frequent with spastic paralysis of both feet the knee and hip movements being unimpaired so that the centres for the bladder and foot must be close together and therefore that of the bladder probably in the paracentral lobule. Later Foerster (1931) described a case of meningioma of the falx cerebri in which there was spastic paralysis of both legs and retention of urine over a number of years. It therefore seems certain that bilateral lesions of the paracentral lobule adjoining the ascending frontal convolution can produce marked defects in micturition extending over years.

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## CHAPTER XIX

### EXAMINATION OF THE BLADDER • CATHETERS

**E**XAMINATION of the bladder should be carried out along systematic lines. In the first place a careful history should be taken and a specimen of urine sent for pathological examination. X ray pictures of the whole urinary tract should be available for study. Clinical examination, by the ordinary methods of inspection palpation rectal examination etc., is only likely to detect grosser abnormalities. General examination of the individual should never be omitted. This may for example reveal the presence of disease of the nervous system and indicate that bladder symptoms are secondary in nature.

Final diagnosis is rarely possible unless special methods are employed. These comprise catheterization and other forms of instrumentation including cystoscopy supplemented in some cases by cystography.

The ability to inspect the interior of the bladder and to visualize its outline places the investigation of bladder abnormalities among the most exact of modern methods of diagnosis.

#### PRE-INSTRUMENTAL EXAMINATION

1 **Physical examination—INSPECTION**—As the bladder fills the apex rises out of the pelvis coming in contact with the anterior abdominal wall immediately above the symphysis pubis. When grossly distended it gives rise to a rounded swelling in the suprapubic region the outlines of which become more distinct when the abdominal muscles are relaxed (*i.e.* when the patient is lying flat with the head flexed and the knees drawn up). The swelling is often asymmetrical the fundus usually being deviated towards the right side. In severe degrees the fundus may attain the level of the ensiform the distended bladder appearing to fill the entire abdomen.

*In men the condition is usually quite obvious but in women where a distended bladder can be readily confused with other pelvic tumours the true nature of the swelling may only be determined after a catheter has been passed.*

**PALPATION**—With the abdominal muscles relaxed the suprapubic region is palpated with the flat of the hand. Under normal conditions the fundus of the full bladder can sometimes just be felt in thin subjects. Pathological distension gives rise to an elastic suprapubic swelling with a fairly distinct convex upper border. The swelling is very tender when the condition is an acute one but in chronic states deep pressure will only give rise to slight discomfort.

Apart from the distended bladder it is sometimes possible to feel tumours which have infiltrated the anterior wall or huge vesical calculi. Tenderness of the symphysis pubis may be present in cases of prevesical cellulitis and this becomes more marked when the infection has spread to the adjacent bone.

Percussion may be fallacious owing to the fact that a loop of bowel will often lie in front of the bladder and cause the swelling to be resonant.

**RECTAL EXAMINATION**—In the male the rectal surface of the bladder comprises a small triangular area with sides about 1½ in in length which is separated from the anterior wall of the rectum only by the rectovesical fascia (Fig 107). The base of the triangle is situated above and is bounded by the reflection of the peritoneum at the bottom of the rectovesical pouch. The line of reflection of the peritoneum from the bladder to the rectum is situated about 1 in above the level of the interureteric bar and roughly 10 cm from the anus (Gray). The sides of the triangle are formed by the converging vasa deferentia and seminal vesicles which intervene between the rectum and bladder. The apex of the triangle lies immediately above the median groove of the prostate gland.

Rectal examination of the bladder can be carried out either in the knee chest or the semi lithotomy position. The former position is less satisfactory for this purpose because the bladder tends to fall forward out of reach of the

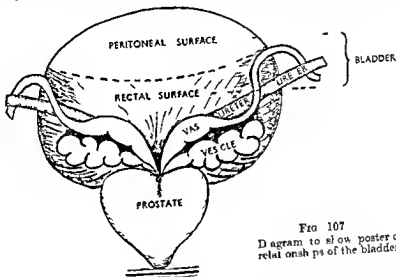


FIG 107  
Diagram to show poster or  
relations of the bladder

examining finger. In the semi lithotomy position the patient reclines on a couch with the head well flexed on a pillow and the flexed knees supported by stirrups or held by an assistant. The flat of the free hand is placed on the suprapubic region so as to displace the bladder backwards towards the rectal examining finger. Bimanual rectal examination of the bladder is then carried out (Fig 108). By this means it is possible to feel not only the prostate gland and seminal vesicles and post trigonal region but in thin subjects much of the rest of the bladder as well. It is always advisable to make sure that the bladder is empty (by catheterization if necessary) before the examination is carried out because the rectal surface of a distended bladder will tend to bulge backwards and obscure the prostate and other landmarks in that region. It should also be remembered that the backward bulge of a distended bladder may closely simulate a collection of pus in the rectovesical peritoneal pouch and mistakes in diagnosis have often been made by omitting to empty the bladder prior to the examination of suspected cases of pelvic abscess.

The extent of malignant infiltration of the bladder base by neoplasms of the bladder or prostate can be readily determined by bimanual rectal examination. Between the rectal surface of the bladder and the wall of the rectum is a potential space—this is the posterior compartment of the perivesical

space—a cellular space which completely surrounds the extraperitoneal part of the bladder. Collections of blood or extravasated urine may give rise to a boggy thickening of this area in cases of extraperitoneal rupture of the bladder. Infections of this cellular tissue are not uncommon and may cause a stony hard area of infiltration in the region of the bladder base. In severe degrees the whole bladder base prostate and vesicles will appear to be fixed in a cement like mass of inflammatory tissue.

In addition the veins and lymphatics from the bladder base pass out to the side walls of the pelvis along with those of the upper portion of the prostate gland tending to run parallel with and for the most part anterior to the seminal vesicles. Lymphangitis lymphatic involvement by neoplasms or thrombo



FIG. 103

B manual rectal examination of the bladder

phlebitis may affect these vessels and give rise to a characteristic thickened cord running outwards from the bladder base to the side walls of the pelvis.

The various pathological lesions of the bladder which may be appreciable by bimanual rectal palpation may be summarized as follows —

- A Within the bladder very large calculi intravesical bladder growths
- B In the bladder wall thickening from hypertrophy malignant infiltration
- C Outside the bladder perivesical cellulitis perivesical effusions lymphatic extension of growths

**VAGINAL EXAMINATION**—The anatomical differences in the two sexes make the bladder in the female more accessible to external examination. The short urethra the trigone and bladder base are readily palpable in the anterior vaginal wall and it is sometimes possible to feel the juxta vesical inch or so of ureter through the lateral fornix.

2 **Examination of the urine**—Whenever possible the patient should pass a specimen of urine in the presence of the surgeon so that any alteration in its naked eye characters and the way it is passed can be noted. Important



observations can often be made when certain types of bladder disease are present —

- 1 The passage of flatus and faeces through the urethra with the urine is diagnostic of vesico colic fistula
- 2 The passage of large thick intestinal masses of muco pus is one of the main characteristics of any case of chronic alkaline cystitis
- 3 Irregular semi gelatinous masses of epithelial cells may sometimes be found in the urine of patients with papillary tumours of the bladder and large sloughing masses of epithelium may appear in cases of gangrenous cystitis. The entire mucosa may be involved in severe forms of gangrenous cystitis and a complete cast of the bladder may be passed per urethrum when the slough separates
- 4 When hematuria is present the relationship between bleeding and the act of micturition will sometimes prove a valuable guide to the site of the lesion. Terminal hematuria is always derived from the bladder or posterior urethra. Clots formed from bleeding into the bladder are usually round or irregular when passed in the urine thus differing from the long pencil like clots derived from the kidney and ureter. The latter must not be confused with the thicker urethral clots which may appear in the urine after instrumentation and are due to urethral hæmorrhage from local trauma

In males the *two glass test* is generally employed. After cleansing the glans and meatus the patient empties about half the contents of the bladder into a clean conical glass the remainder being passed into a wide necked sterile bottle. The first specimen which can be conveniently used for chemical tests is contaminated by the non pathogenic bacteria which normally inhabit the anterior urethra. The second specimen consists of uncontaminated bladder urine (mid stream specimen) and can be sent for pathological examination. In females it is only possible to obtain an uncontaminated specimen of bladder urine by passing a catheter or else by means of a cystoscope when cystoscopic examination is being carried out.

3 X-ray examination—As the symphysis pubis lies directly in front of the prostate gland and trigone of the bladder it is necessary to take a slightly oblique view of the pelvis in order to obtain a satisfactory radiogram of the bladder area. Marshall and Cochrane Shanks recommend that the tube be centred perpendicularly over a point midway between the anterior superior iliac spines with 5 to 10 degrees of caudal angulation. The adoption of a constant fixed position such as this is necessary in order to obtain uniformity otherwise considerable variations will be observed in different views of the same subject. The exposure should include the entire true pelvis the iliac crests and an area well below the pubic arch.

In a good plain film a faint shadow outlining the bladder will sometimes be seen when the viscus is full (Fig 109). When moderately distended the normal bladder is oval in shape with its long axis placed transversely its lower border is constant approximately following the line of the upper margin



Fig 109

Radiogram of pelvis note faint outline of bladder

of the pubic portion of the pelvic girdle. When fully distended the bladder becomes more rounded in shape and the variable convex upper border may reach the level of the sacral promontory. The lateral limits of the bladder vary to some extent with the degree of distension but rarely extend beyond a vertical line drawn through the middle of the obturator foramen (Thomson Walker). The area of the prostate gland lies directly behind the symphysis pubis. Radiology of the bladder is most useful in the demonstration of stone (see p 938). Other bladder conditions giving rise to X ray opacities (*e.g.* encrusted tumours encrusted cystitis calcification of the bladder wall etc.) are uncommon. Extravesical opacities which may cause confusion include phleboliths calcification of pelvic vessels ureteric calculi etc. The special X ray characters of these pelvic opacities are dealt with elsewhere (see p 938).

### SIMPLE INSTRUMENTAL EXAMINATION

Much useful information can be obtained regarding the state of the bladder by passing a catheter. In the first place the free passage of the instrument will exclude the presence of certain forms of urethral obstruction (*e.g.* stricture or urethral calculus) and secondly the quantity of residual urine (*i.e.* urine remaining in the bladder after micturition) can be ascertained. This provides



FIG. 110

A Single rubber catheter with blunt solid end. B Open ended rubber catheter.

valuable test of bladder function the quantity of residual urine being the measure of the ability of the bladder to empty its contents. The effects of urethral obstruction or of organic nervous disease on the contractile power of the bladder can only be accurately gauged in terms of residual urine.

Other information may sometimes be gained by instrumentation *e.g.* the characteristic grating sensation caused by contact between a catheter and a vesical calculus or when a fragment of bladder growth is caught in the eye of the catheter on withdrawal.

**Catheters**—The catheter appears to have been among the first surgical instruments to be devised by man. The writings of the Egyptians disclose the fact that catheterization and other forms of instrumentation were practised in the year 3000 B.C. (Thomas 1933). The earlier instruments consisted of simple tubes of bronze or tin. At a later date attempts were made to adapt the instrument to the tortuous course of the male urethra firstly by the introduction of curves and finally by the manufacture of catheters from suitable plastic materials such as rubber or woven silk. Modern catheters are made of either metal rubber or woven silk.

**1 RUBBER CATHETERS (Fig. 110)**—The ordinary (Jacques) variety has a solid rounded terminal end beyond the eye and a trumpet shaped distal extremity to fit a bladder syringe. Ricmann's pattern is similar but has an upturned and slightly bulbous terminal end. Various types with an open terminal end (plain or whistle tip) are made for special purposes *e.g.* tying in after prostatectomy. Catheters with an expanded terminal end (Malicot or

de Pezzer patterns) are inserted by means of an introducer and are often used for continuous bladder drainage.

**Advantages**—They are cheap, durable and easily sterilized by boiling. They adapt themselves readily to the curves and irregularities of the urethra and are less likely to cause trauma than the more rigid types when used inexpertly.

**Disadvantages**—Being soft and supple they are rather difficult to control and are apt to become contaminated by touching the patient or the bed clothes whilst being passed. This does not apply to the same extent to the Tiemann catheter of which the rubber is of a firmer consistence. Owing to their relatively thick walls the lumen is more likely to become blocked by clot etc.

2 **WOVEN SILK (GUM ELASTIC) CATHETERS** are semi rigid instruments made of woven silk impregnated with a stiffening agent such as linseed oil. A special varnish is employed in the finishing process and the instrument highly polished so that its surface becomes smooth, glossy and durable. The solid terminal end is modified in various ways to overcome abnormal curves and constrictions of the urethra. These forms comprise upturned (coude), double curve (bicoude), olivary and filiform (whip) varieties (Fig 111 A to H).

The curve of the proximal end can be further increased by the use of a wire catheter introducer, a useful manoeuvre when marked distortion of the posterior urethra has been caused by middle lobe prostatic enlargement. With drawal of the introducer just as the point of the catheter enters the posterior urethra will further increase the curve.

**Advantages**—Semi rigid catheters can be held by the distal end between forefinger and thumb while being passed and are unlikely to become contaminated. They are less liable to become blocked owing to their relatively wide lumen. The wide variety of types can be adapted to varying conditions in the urethra.

**Disadvantages**—They are more expensive owing to the complicated process of manufacture. Being semi rigid they are more liable to traumatize the urethra than rubber catheters when roughly passed.

**Sterilization**—The better types can be boiled. Sterilization by immersion in antiseptics (e.g. one hour in 1:2000 oxycyanide of mercury) is less reliable and also tends to soften the instruments. At St Peter's Hospital gum elastic instruments are sterilized by means of heated formalin vapour in a special cabinet. This method is safe, economical and time saving and is suitable for out patient departments where instruments are required in large numbers. Small metal sterilizers in which the formalin can be heated and which are suitable for consulting rooms are also available (Fig 112). So called cold sterilization by means of formalin tablets or powder is less effective and is often carried out in a most perfunctory manner.

3 **METAL CATHETERS** are made of silver or stainless steel. The proximal end is curved (simple Bouque or long prostatic curve). Thomson Walker's catheter is made in a large size with its distal end adapted to fit a Bigelow's evacuator. It is of great value in rapidly evacuating clots from the bladder in cases of clot retention.

**Advantages**—Metal catheters are indestructible and can easily be sterilized by boiling. Their wide lumen makes them very suitable for washing out the bladder in cases of cystitis.

**Disadvantages**—Owing to their rigidity they are very likely to inflict severe trauma when force is used and if pushed too vigorously into an inflamed bladder the point of the instrument may perforate the anterior wall. If tied

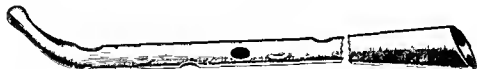
A



B



C



D



E



F



G



H



FIG 111

A, Olvary coude catheter (in rubber, Tiemann) B, Olvary coude catheter with two eyes (Pasteau's) C, Marion's catheter (rubber) D, Olvary catheter E, Coude catheter F, Bi coude catheter G, Whip catheter H, Catheter introducer

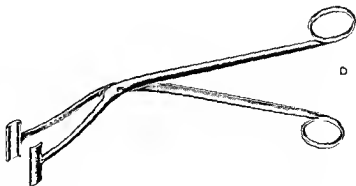
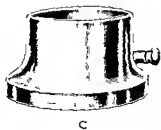
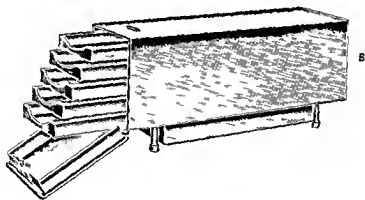
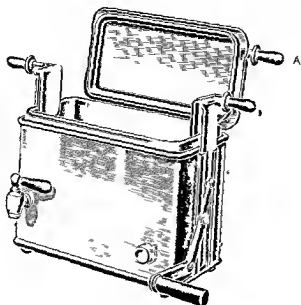


FIG 112

A, Instrument sterilizer B, Formalin sterilizer for gum-elastic catheters and bougies  
C Winsbury White lubricant well D Sterilizer forceps

into the urethra for any length of time they are peculiarly liable to be followed by periurethral suppuration and penile fistula

*The bladder sound*—This is a special solid metal instrument with the proximal end slightly upturned and a bulbous tip. Until the end of the last century it was used exclusively for the diagnosis of bladder stone. "Sounding for stone" has now been replaced by more exact methods although in cases where a cystoscope cannot be passed or where no lotion can be injected into the bladder a sound is still sometimes useful for purposes of diagnosis.

**TECHNIQUE OF PASSING CATHETERS**—Care should be taken to eliminate

all sources of contamination and the adequate sterilization of catheters by the methods already described must be strictly observed. As the operator's hand need only touch the proximal end of the instrument the wearing of rubber gloves is unnecessary.

**PREPARATION OF THE PATIENT**

—In the male the glans and external meatus are thoroughly cleansed with a swab saturated with oxycyanide of mercury (1:4000) or other mild antiseptic solution. The bladder should be emptied immediately before instrumentation in order to remove the bacteria normally present in the anterior urethra. As an added precaution some urologists also irrigate the anterior urethra with a mild antiseptic. The surrounding parts are then covered with sterile towels. (A special towel with a central aperture is useful for this purpose.)

**LUBRICANTS**—The catheter should always be well lubricated. Various proprietary catheter lubricants consisting usually of tragacanth emulsion impreg-



FIG. 113

1. Insertion of soft or semi-rigid catheter. First manoeuvre.

nated with an antiseptic such as phenol 0.5 per cent or alternatively liquid paraffin (boiled for twenty minutes in a water bath) can be used.

Glycerine is unreliable because of difficulties in sterilization; it is also likely to cause severe local pain when it comes in contact with the urethral mucosa.

**PASSAGE OF SOFT OR SEMI-RIGID CATHETERS**—The penis is extended well forwards towards the abdomen so as to straighten out the folds of the anterior urethra and the catheter is cautiously advanced as far as the bulb (Fig. 113). When the proximal end of the catheter reaches the triangular ligament a slight sensation of resistance will be felt. The penis is then depressed so as to straighten out the urethra thus enabling the point of the catheter to enter the posterior urethra. No force must be used at this stage if the instrument does not pass easily but the manoeuvre of extending and depressing the penis

should be repeated at the same time slightly withdrawing and advancing the catheter until it finally engages the posterior urethra. It will then slide easily into the bladder (Fig 114).

**PASSAGE OF RIGID CATHETERS**—The technique of passing metal catheters or flexible instruments stiffened by means of an introducer is similar to that employed for the passage of steel bougies (see p 378).

In the first position the instrument is passed along the urethra in a course roughly parallel to Poupert's ligament with the convexity of the curve directed upwards until its point reaches the triangular ligament (Fig 115). The instrument is then turned through an angle of forty five degrees so that the distal end comes to lie in front of the symphysis pubis and the curve directed downwards (*semi tour de maître*). The beak of the instrument acts as a fixed point for the movement of rotation (Fig 116). Finally the distal end of the instrument is depressed so that its curve corresponds to that of the posterior urethra. When it is felt to engage the posterior urethra it is gently advanced to the bladder (Fig 117). At no time must any force be used.

Difficulties similar to those experienced during cystoscopy may be encountered (see Cystoscopy).

When semi rigid (gum elastic) instruments are employed without an introducer they may be difficult to pass and are likely to produce trauma if they are not very flexible. They should therefore be well softened in hot water before use.

**Catheterization of the female** is usually a simple procedure because of the short almost straight urethra. The patient should be prepared by carefully swabbing first the vulva and then the external meatus from before backwards. Special short female catheters made of metal or rubber are usually employed but any flexible male catheter does well. The glass variety is not recommended owing to the risk of breakage. A goose-quill may be used in an emergency.

**Dangers of instrumentation**—**INFECTION** (catheter fever)—Severe pyrexia, rigors or even septicæmia may follow the passage of instruments (see p 380).

**RETENTION OF URINE**—is generally due to reactionary cedema following urethral trauma and is more likely to occur when an obstruction is present. It is often associated with urethral hæmorrhage and the latter when severe may give rise to extensive clotting in the urethra and bladder. Obstructing clots in this position may block the outlet of the bladder and give rise to retention of urine (clot retention).

**CATHETER SHOCK**—(See Urethral Shock p 378).

**PROPHYLAXIS**—(See p 379).

## CYSTOSCOPY

Cystoscopic examination is an essential part of any bladder investigation and it is necessary for all who have to deal with bladder diseases to become thoroughly familiar with this valuable diagnostic procedure. It must be remembered however that in some circumstances cystoscopy may be harmful to the patient.

Contraindications are as follows —

- 1 Acute infections of the urinary or genital tracts where the passage of an instrument may force bacteria along the ejaculatory ducts and lead to epididymitis or vesiculitis.



FIG. 114

Passage of soft or semi-rigid catheter—second manoeuvre



FIG. 115

Passage of rigid catheter—first manoeuvre





FIG 116  
Passage of rigid catheter, second manœuvre



FIG 117  
Passage of rigid catheter, third manœuvre

- 2 Urethral obstructions where severe trauma may be caused by attempts to force a cystoscope along a narrowed or distorted urethra Preliminary dilatation with bougies is necessary in such cases before attempting cystoscopy
- 3 Chronic over distension of the bladder where rapid emptying may be followed by severe renal hæmorrhage or suppression of urine
- 4 Gross prostatic enlargements especially when the urine is clear In such cases the additional information gained by cystoscopy is outweighed by the severe trauma inevitably caused by the instrument

**The examining cystoscope**—All refracting cystoscopes are modifications of Nitze's original instrument Their types are legion and it is not proposed to describe them in detail In its simplest form (Ringleb pattern Fig 118) the modern examining cystoscope consists of —

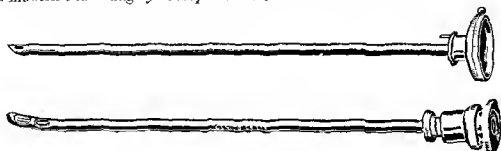


FIG 118  
Ringleb examination cystoscope

**THE SHEATH** a straight hollow metal tube which also serves as a catheter Escape of fluid from the bladder is prevented by a valve at the distal (external) end of the sheath which can be opened by inserting a faucet The sheath contains the internal lighting system comprising a lamp set at an angle at the proximal (internal) end and connected by fine wires running in the walls of the sheath to the switch terminal at the distal end

The **TELESCOPE** is a very thin fragile metal tube containing the optical system which consists of a right angled prism with a correcting series of lenses

The **EXTERNAL LIGHTING SYSTEM** includes battery with rheostat lighting cords and switch

The instrument is made in sizes 18 to 20 Charrière for adults Smaller instruments (sizes 14 to 18 Charrière) are available for use in children

The irrigating cystoscope (Fig 119) is provided with *inflow and outflow* channels so that lotion can be run into or out of the bladder while inspection is being carried out This type of instrument is useful in cases where the medium becomes rapidly obscured by hæmorrhage or where the capacity of the bladder has become greatly reduced by cystitis stone growth etc

In the ordinary cystoscope the prism is set to give an image at right angles to the axis of the telescope (indirect vision) By tilting the prism at various angles a direct foroblique or retrograde view of the bladder can be obtained

**Sterilization of cystoscopes**—**BOILABLE CYSTOSCOPES** are now obtainable (the telescope is stamped B to avoid confusion with non boilable types) The instrument is placed in tepid water in the sterilizer using the special perforated metal box provided and brought to the boil it is then boiled for five minutes It must always be allowed to cool off in the air before use and cold water must never be used for this purpose

NON-BOILABLE CYSTOSCOPES are sterilized by immersion in antiseptic solutions (*e.g.* 1-20 carbolic for twenty minutes). Special containers of metal or glass with metal slots or racks to hold the separate parts of the instrument are made for the sterilization of cystoscopes. The slots should be regularly

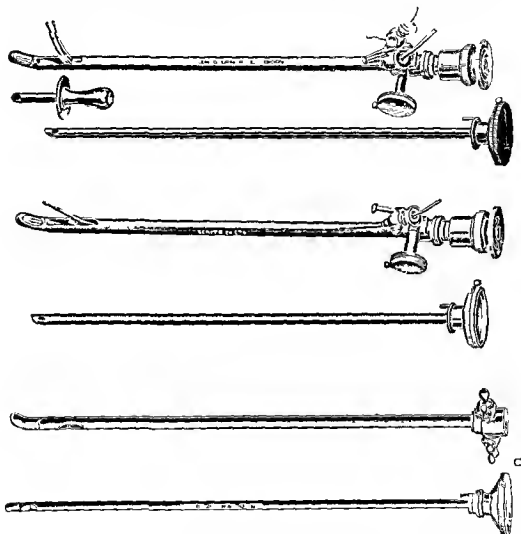


FIG. 119

A Ringleb double catheterizing cystoscope B Ringleb angle catheterizing cystoscope  
C Irrigating cystoscope

cleaned and boiled, otherwise they are liable to accumulate dirt. The instrument must be immersed in sterile water to remove all traces of antiseptic before it is used. Valves and faucets should be boiled.

Sterilization by formalin vapour is a method favoured by few as it is rather tedious and often uncertain. By the "cold" method formalin powder is placed at the top of a special sealed cystoscope container, the heavy vapour falling around the instrument. To be effective, the instrument should be in contact with the formalin vapour for at least two days.

By the warm method the formalin is heated to a temperature of fifty degrees Centigrade by means of a special stove. The warm formalin vapour should be in contact with the instrument for at least two hours. The instrument should be immersed in water to remove all formalin before use.

**Care of cystoscopes**—After use the telescope is removed and the valve unscrewed. The sheath is thoroughly washed with soap and water and the exterior swabbed with methylated spirit. The interior of the sheath is cleansed by means of a pledget of wool attached to the roughened end of the special cleansing rod provided for the purpose. The telescope and valve are swabbed with spirit and washed under the cold tap. All parts should be thoroughly dried and replaced in their special box for use when next required. The extreme delicacy of cystoscopes must be impressed on nurses or orderlies who have the

handling of these instruments. The telescope owing to its thin walls is the most vulnerable part and if dropped or even picked up with forceps will become bent thus throwing the optical system out of alignment. The surgeon should also remember to ease the compression screw of the valve before passing the telescope. If force has been used when introducing the telescope the distal end will become dented or bent and cause cutting off of portion of the field.

**LUBRICANTS**—water soluble jellies are preferable to paraffin for cystoscopy as the latter tends to form a film over the surface of the window.

**Position of the patient**—It is important to place the patient in as comfortable a position as possible. The semi lithotomy

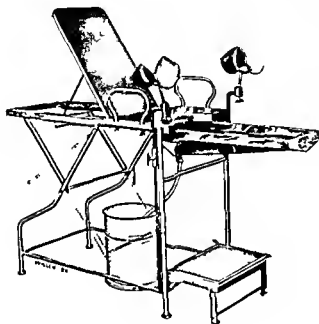


FIG. 110  
Cystoscopy chair

position is favoured by most urologists and special cystoscopy chairs with knee or foot supports are generally used (Fig. 120). As an alternative (in males) the patient can be examined lying flat on a couch with the buttocks raised by means of a cushion. (See also preparation for passing of catheters p. 244.)

**Preliminary anaesthesia**—In FEMALES anaesthesia is rarely required. In very nervous young women especially where the urethral opening is small it is sometimes necessary to cocaineize the external meatus. A few cocaine crystals or a swab saturated in 20 per cent cocaine solution applied locally will usually abolish all pain.

In MALES the difficulties of instrumentation are greater and anaesthesia is more frequently resorted to. Although gentleness and skill on the part of the operator will largely do away with the need for this and there are cases where it is essential and although the discomfort from the procedure is not severe, this is always lessened by a local anaesthetic. Very nervous individuals will resist all attempts to pass an instrument by contracting the abdominal muscles and compressing the triangle against the triangular ligament at the same time.

throwing the perineal muscles into an intense spasm. Even if the instrument can be forced through the spastic compressor urethra it will almost certainly be held up in the posterior urethra which is closed like a concertina. In this type of patient some form of sedative (e.g. morphia) is essential before examination is attempted. This may be combined with a minimal intravenous dose of pentothal (0.2 to 0.3 grammes) injected rapidly immediately before passing the instrument.

#### LOCAL ANÆSTHESIA—(See p. 646)

LOW SPINAL ANÆSTHESIA will completely abolish sensation from the urethra and bladder base and is indicated when painful conditions involving these areas are present e.g. tuberculous cystitis with ulceration. This form of anaesthesia is particularly helpful in the latter condition having two great advantages over general anaesthesia. Firstly renal function and sensation



FIG. 121

Insertion of cystoscope for transurethral

are unimpaired so that specimens of urine can be readily collected from the kidneys and (if necessary) ascending pyelography can be performed with the co-operation of the patient. Secondly the sensation of distension of the bladder is not altogether abolished by spinal anaesthesia and hæmorrhage caused by over filling of an ulcerated bladder is less likely to occur than in an unconscious patient.

GENERAL ANÆSTHESIA is seldom required for cystoscopy in adults. In children however it is the only suitable form of anaesthesia for this purpose. The dangers of inflicting severe urethral trauma and of over distending the bladder or renal pelvis must always be borne in mind while examining these small patients.

**Introduction of the cystoscope**—As a preliminary to the examination the lighting system should be tested and the strength of the current fixed.

The penis is drawn up and extended in front of the abdomen and the cystoscope allowed to slide in by its own weight until the beak is obstructed by the triangular ligament (Fig. 121). (The point of the beak is directed upwards throughout the passage of the instrument.) Keeping the beak in contact with

the compressor urethræ the distal end of the cystoscope is then gently lowered until the axis of the instrument is nearly horizontal. Once engaged by the membranous urethra the distal end of the instrument is further depressed until it enters the posterior urethra (Fig 122). At this stage it is often necessary to depress the instrument well between the patient's thighs in order

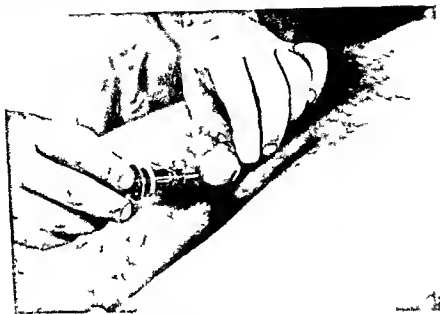


FIG 1

Engagement of cystoscope posteriorly

to follow the curved upper part of the posterior urethra. The whole operation should be carried out gently, smoothly and slowly and the axis of the instrument kept strictly in the sagittal plane. When the instrument is in the bladder there will be a sensation of increased mobility of the proximal end and a limited range of movement (rotation etc.) can now be carried out without increasing the discomfort to the patient. The telescope is next withdrawn



FIG 123

Thomson-Walker bladder syringe

and the faucet inserted for washing out the bladder. Bladder lavage is carried out either by means of a syringe (Fig 123) or irrigator. The lotion used must be a crystal clear solution, either normal saline or sterile water, all serve equally well. The temperature of the lotion must be kept below that of the body. When an antiseptic solution such as oxymercure of mercury (1:4000 to 1:8000) is used care should be taken to remove all lotion from the bladder when the examination has been completed. Page and Wilson have stressed this danger, reporting three fatal cases of acute mercurial poisoning after oxymercure of mercury had been retained in the bladder after

cystoscopy Mercurial solutions should be avoided in patients who are taking iodides by the mouth

After the washout has returned clear the bladder is filled until slight discomfort is complained of the faucet is withdrawn the telescope reinserted and the lighting switch connected

**Difficulties of cystoscopy**—In passing a cystoscope or any other rigid instrument along the *normal urethra* most difficulties will be found to arise at two sites, firstly immediately below the triangular ligament at the junction of the fixed and mobile parts of the urethra and secondly mid way along the posterior urethra at the level of the verumontanum. A common mistake of the inexperienced cystoscopist is to fail to appreciate the exact position of the entrance to the membranous urethra either depressing the cystoscope too soon, when the beak of the instrument is only as far as the suspensory ligament of the penis or too late when the beak is at the bottom of the cul de sac of the bulb. In either case the instrument will be caught in the mucosa and forcible attempts to advance it farther may tear a false passage in the urethra at this level. When compressor spasm is present the difficulties in negotiating this part of the urethra will be further increased. Irregularities and pockets in the posterior urethra are not uncommon and these may be marked enough to catch the point of an instrument. False passages at this level will tunnel the prostate and burrow under the triangular ligament. Severe lacerations in this area may involve the extraperitoneal part of the bladder.

The feel of the various pockets and irregularities in the normal urethra can only be appreciated by the surgeon after he has served a long apprenticeship in a cystoscopy clinic and no textbook description can impart this knowledge.

The commoner *abnormalities* which may render cystoscopy difficult or impossible are large scrotal tumours suprapubic scars fixed to the bone narrowing or distortion of the urethra from any cause. In such cases preliminary exploration by passing a curved metal bougie is often a great help. As already stated the patient with gross prostatic enlargement should only be cystoscoped when special indications are present e.g. when repeated attacks of hæmaturia suggest the presence of a bladder growth.

Difficulties may arise in obtaining a clear view of the interior of the bladder after the cystoscope has been passed. In some cases the bladder may repeatedly discharge its contents by going into spasm each time lotion is injected. This is very liable to occur when the lotion is too hot as the bladder is much more sensitive to high temperatures than to low ones. By keeping the instrument in a fixed position and gradually increasing the amount of lotion injected the bladder and urethra will be found to become more tolerant in most cases until finally the inspection of the bladder becomes possible.

The view may become obscured by the presence of pus blood or large intravesical growths. Repeated irrigation of the bladder may be necessary before the lotion is returned clear or else a special cystoscope for continuous flushing may be employed.

**Bladder orientation**—Seen through the cystoscope the mucosa of the bladder is a clean smooth glistening membrane. Its colour varies from white to sandy yellow, depending on the brightness of illumination the portion of the bladder wall inspected the lotion used and the temperature at which it is injected. Arteries are fairly numerous the larger ones running a more or less straight course before breaking up into delicate wavy arterioles. Vascularity is most marked on the bladder base particularly on the trigone where the numerous vessels which radiate fanwise from the internal meatus make this area appear

unsatisfactory owing to profuse hæmorrhage severe cystitis or large size of the growth

2 Cystography will demonstrate an extravasation of urine when rupture of the bladder has occurred. It may be used for this purpose in cases where signs and symptoms of ruptured bladder are inconclusive

3 The mechanism of ureteric reflux can be studied in cases where the valve at the lower end of the ureter has become incompetent. In severe degrees of chronic bladder obstruction the whole of the upper urinary tract of one or both sides may thus be visualized (uretero pyelogram)

Two methods of cystography may be employed —

1 Instrumental cystography—The contrast medium is injected through a catheter until slight suprapubic discomfort is complained of. Various media are employed the best being a 5 per cent solution of any of the drugs used for intravenous pyelography (iodoxyl B P) or 15 per cent sodium bromide. Iodides are unsuitable for this purpose as they are liable to be followed by dysuria and hæmaturia. Air should never be used not only is the contrast shadow poor but it may give rise to air embolism

Radiograms are taken in the antero posterior and oblique planes with the bladder filled. Similar views are taken after micturition. It should be remembered that the shape of the bladder is altered for an unknown length of time after the passage of a urethral instrument. Other factors such as a desire to micturate or rapid filling of the bladder by injection may also have to be taken into consideration when instrumental cystograms are studied. For these reasons the outline of the bladder under natural conditions can only be accurately reproduced by the intravenous method. Forced distension by injection will be necessary to demonstrate many diverticula however owing to the comparatively small size of the opening between the sac and the bladder

2 Excretory cystography—It is usual to take a picture of the pelvis half an hour after intravenous urography. This will generally outline the bladder in a state of moderate distension. To prevent dilution the bladder should be emptied before the injection is given

It will often be noted that the outline of the bladder as shown by urography is asymmetrical one side or other of the fundus being indented (Fig 124). This is due to differences of pressure exerted by the intestinal contents and is often most marked when the pelvic colon is loaded. This appearance is without any pathological significance

Differences in concentration of the medium in the lower ends of the ureters and the bladder may clearly demonstrate the relationship between these structures

Unfortunately many intravenous cystograms are worthless from the radiological point of view because of poor concentration or the presence of gas in the rectum and pelvic colon. The advantages of this method are those of convenience complete absence of any local reaction and the fact that the bladder is shown under normal conditions without artificial distension or instrumental interference

In cases where catheterization is undesirable intravenous cystography may be utilized to give an approximate estimation of residual urine



FIG 124  
Normal excretory cystogram



## EXPLORATION OF THE BLADDER

Because of the wealth of diagnostic methods at the disposal of the surgeon, exploration of the bladder is only likely to be necessary in exceptional circumstances

Emergency cystotomy is sometimes required in cases of severe and uncontrollable hæmorrhage from the bladder with clot retention in order to turn out the clots and to deal with the source of the bleeding. Ruptures of the bladder especially those associated with war wounds are often difficult to diagnose and in view of the grave dangers of delay in treatment, it may be necessary to explore the bladder in many doubtful cases

## APPENDIX

At the Congress of the French Association of Urology in 1926 it was decided that all sizes should be graduated by a sixth of a millimetre (Benique scale) instead of by a third of a millimetre (Charrière scale). Nevertheless the Charrière scale remains in popular use. In the British Empire and the United States it is commonly designated by the letter F (e.g. 16 F) which is used in this work. Ureteric catheters are commonly marked in the Benique scale

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## CHAPTER XX

### DISTURBANCES OF MICTURITION AND VARIATIONS IN THE AMOUNT OF URINE EXCRETED

#### VESICAL PAIN

**I**N relation to micturition vesical pain may precede or occur at the moment of commencing or ending

Vesical pain which precedes micturition is due to vesical tension and is most severe when the whole bladder is inflamed

The pain which occurs at the moment of commencing micturition is caused either by inflammation which is localized to the neck of the bladder or an obstructive condition in this situation

The pain at the end of micturition is most commonly due to inflammation less commonly to stone or new growth

There is little risk of confusing vesical pain with that originating in neighbouring organs because there are other symptoms present which are characteristically of vesical origin

Vesical pain has three characteristics with regard to location in the bladder region at a distance from the bladder with micturition

**Pain in the bladder region**—This is located in either the pubic or supra pubic area or deep in the pelvis Except in the last instance the patient is able to indicate the seat of the pain

**Pain at a distance from the bladder**—This is noted at the tip of the penis in the male and at the external urinary meatus in the female Less frequently the pain is noted to one or other side in the lower abdomen When vesical disease is complicated by a perivesical lesion pain radiates along the pelvic nerves into the perineum buttocks sacral region thighs and groins

**Pain with micturition**—The pains which occur independently of micturition are often accompanied by frequent and urgent micturition which culminates in severe pain just as the act is completed The pain in these circumstances is felt at the neck of the bladder in the glans or at the external urinary meatus When these painful attacks are severe they may be accompanied by rectal tenesmus which precipitates the passage of flatus or even faeces These different types of vesical pain can occur spontaneously or be precipitated or aggravated by various causes in a very sensitive bladder even slight body movements shaking the bed or the bringing of a door in other cases suddenly changing from the resting to an active state rectal or vaginal examination the passage of urethral instruments tension in the bladder caused by the injection of fluid

**Cystalgia with urethro-trigonitis**—This condition is sometimes met with after a widespread cystitis has subsided or may exist without any such preceding attack There is always pollakiuria as well The urine in the cases is often perfectly clear to the naked eye and microscopically may contain bacteria but no pus

The cystoscope shows the inflammation in the bladder to be localized strictly to the front of the trigone Urethroscopy shows that the posterior

urethra is also the seat of inflammation. The urethritis is probably the origin of the cystitis.

**In generalized cystitis**—In these circumstances the vesical pains are accompanied by pyuria, increased frequency and urgency of micturition. The inflammation may, of course, be due to any diseased condition of the bladder, prostate, urethra or kidneys, or to disease of an extra-urinary pelvic organ. In certain pathological conditions of the kidney or ureter the above signs may exist with little or no cystitis. Cystoscopy will be necessary to make matters clear.

**Vesical calculus**—Pain on movement, as a result of impact, or as micturition terminates is the characteristic feature.

**Malignant growth**—This gives rise to vesical pain, with frequency, etc., and has hæmaturia as a prominent feature.

**Acute complete retention of urine**—This gives rise to a constant pain and recurring spasms from the bladder contractions which attempt to overcome the obstruction. The palpably distended bladder indicates the degree of the retention.

**Chronic incomplete retention of urine**—This is sometimes seen after operation, and gives rise not to severe pain but to a vague feeling of discomfort in the lower abdomen. The condition is likely to be overlooked if a distended bladder is not palpated.

**Chronic cystitis with pericystitis**—This often occurs without frequency or urgency, but with pain at the end of micturition which persists for some time. In these cases the urine may or may not contain pus. The persisting pain is due to the inability of the bladder to recontract as it empties.

**Cystalgia without vesical cause**—Spasmodic pains with clear urine and no intravesical cause, as established by cystoscopy, might be reflex from some renal pathology, or due to a neuropathic condition.

Sometimes renal tuberculosis causes cystalgia of this kind before pus appears in the urine.

### URETHRAL PAIN

Diseased conditions of the bladder may cause pain in the region of the glans in the male, or at the external urinary meatus in the female. The discomfort may also be felt along the whole length of the urethra during the passage from the bladder of clots, gravel, pus and bacteria.

A urethral discharge will make it clear that either the urethra or the prostate is at fault, but this may be absent.

It may be necessary where there is uncertainty to carry out urethroscopy.

### HÆMATURIA AND PYURIA

These are discussed under abnormal conditions of the urine.

### POLLAKIURIA

This means an increase in the frequency of passing water. Normally there is no need to micturate during the night, and not more frequently during the day than every four or five hours. These degrees of frequency necessarily vary with a number of circumstances: temperature, exercise, meals and the taking of diuretic substances.

It may be said that with advancing years from one cause or another there is a tendency to an increase in frequency of micturition. Because of the lesser quantity of urine excreted in the tropics frequency of micturition is much less there than in colder climates.

When the frequency is marked there is often urgency as well. The latter may be so pronounced as to amount to incontinence. Sometimes there are painful vesical contractions which give the patient no alternative but to try to empty the bladder whenever they occur. These oft repeated efforts result in the evacuation of only a few drops at a time.

It is unwise to assume that chronic frequency occurs in normal individuals or that pollakiuria is a normal state because it is an old standing condition. A careful inspection of the neck of the bladder and the posterior urethra will often reveal a latent and unsuspected cause of the symptom.

Pollakiuria may be nocturnal, diurnal or may occur during both night and day.

**Nocturnal pollakiuria**—This may occur almost entirely at the beginning of the night & rest the patient having to rise several times in the first hour or so and then remaining undisturbed during a considerable period or there may be a number of fairly regularly spaced risings. Both types occur with cystitis which may cause much frequency in acute cases.

With uncomplicated prostatic enlargement two, three or more micturations occur starting in the early hours of the morning and these go on at regular intervals.

**Diurnal pollakiuria**—When the frequency is precipitated by walking or other movement and especially when accompanied by discomfort or pain in the bladder region vesical calculus should be suspected.

In other cases in which frequency is precipitated by movement the discomfort is seated in one or other kidney which is the seat of stone. In such circumstances the frequency must be considered as a vesical reflex.

*Sensitivity of the neck of the bladder* which is the seat of inflammation may be indicated by the call to micturate on getting up after sitting or lying. The patient is not necessarily disturbed in the same way during exercise.

In women when the erect posture provokes frequency together with a little incontinence genital prolapse vesico-vaginal displacement and pelvic tumour should each be considered.

Pollakiuria not influenced by walking, resting or any particular posture whether accompanied or not by pains which if present are not actuated by any of the conditions just mentioned should make the observer think of some cause which originates in the nervous system.

Vesical neuralgia with pollakiuria is said to occur after widespread cystitis in which there still remains inflammation localized to the base or only to the neck of the bladder. The urine in these cases is often perfectly clear to the naked eye and microscopically often contains bacteria but no pus. There is no justification for assuming in such cases that the symptoms are nervous and not infective in origin. The same state of affairs is commonly found when there is some accompanying disease of a pelvic organ.

Diseases of the spinal cord tabes in particular can be responsible for vesical irritability and frequency with pain. Neuropathic pollakiuria must be seriously considered when a careful investigation has excluded other possible causes.

**Diurnal and nocturnal pollakiuria**—For convenience we may divide cases falling under this heading into groups: those without pus in the urine, those with pus in the urine.

**POLLAKIURIA WITHOUT PUS**—Residual urine or inability to empty the bladder is responsible for some cases

*Simple or malignant prostatic enlargement*—Even when no residual urine is present frequency of micturition both night and day may be a feature. This symptom is due sometimes to hypertrophic or neoplastic change. In malignancy it is due to irritation caused by malignant infiltration.

*Tumours of the bladder*—These can produce frequency for some time before hæmaturia occurs.

*Arteriosclerosis chronic nephritis and glycosuria*—In these cases the symptom is largely dependent upon an accompanying polyuria.

*Renal tuberculosis*—Pollakiuria sometimes occurs in the early stages while the urine is still clear and there is no cystoscopic evidence of the disease and is due to the accompanying polyuria.

Unilateral renal tuberculosis with complete destruction of renal tissue, as in closed renal tuberculosis or massive calcification can also produce this symptom. This is proved by the fact that it ceases when such a kidney is removed.

*Ureteric calculi impacted near the bladder* sometimes produce irritability of the bladder chiefly in the form of frequency of micturition.

*Chronic inflammation of the posterior urethra*—This forms a very important group because most cases of both sexes complaining of mild chronic frequency of micturition fall into this category. Children as well as adults are concerned and many of the former group suffer from enuresis as well. It is only by using the posterior urethroscope as a routine measure that the cause of the frequency can be accurately established. The front of the trigone and the internal urinary meatus are commonly involved in the inflammatory change (urethro cervico trigonitis). The absence of pus and sometimes of bacteria from the urine and the lack of signs of inflammation in the main bladder cavity when cystoscopy is carried out have created the impression that the symptoms are often of nervous origin. Careful observation shows that many of these cases suffer from polyuria as well. The latter feature must therefore play an important part in relation to the increased frequency of micturition.

*Congenital irritability of the bladder*—If all cases falling into the preceding groups are carefully excluded it will be found that this is indeed a rare cause of pollakiuria.

*Extravesical tumours*—By pressure on the bladder both diurnal and nocturnal pollakiuria with clear urine can occur.

*Drugs alcohol condiments*—It is important to realize that many drugs especially when taken over prolonged periods or in excessive amounts can give rise to increased frequency of micturition. It is well to take note that this sometimes happens in connection with urinary antiseptics.

Alcohol in the form of spirits especially increases frequency of micturition not only from diuresis but by causing irritation at the bladder neck. This is more prone to occur when even a mild degree of inflammation is present in this locality. Vinegar and therefore pickles have the same tendency.

**POLLAKIURIA WITH PUS—Cystitis**—This condition commonly causes the frequent and painful passing of turbid urine. The inflammation is tuberculous or non tuberculous and may be a complication of such conditions as enlarged prostate stone diverticulum tumour etc. of the bladder.

*Pyelonephritis* due to different causes at the time of an exacerbation may be accompanied by the frequent passing of turbid urine. Investigation in due course by cystoscopy may establish the fact that the pus is of renal

origin and that the bladder is healthy. In other cases however the bladder is also the seat of inflammation which will explain the pollakiuria.

*Prostatitis and posterior urethritis*—The origin of the symptoms will be clear in the presence of a urethral discharge. In the absence of this however the possibility should be kept in mind and a rectal examination should be made and the water examined in two glasses. As a rule inflammatory changes of the internal genitals are recognized at once with the examining finger. Inspection of the urine passed into two glasses especially after the rectal examination will generally show threads as well as pus in the first glass and that these are absent from the second which may contain pus however. The presence of the latter indicates that the infection has spread from the posterior urethra to the bladder.

*Pollakiuria accompanying renal colic*—Frequency of micturition sometimes occurs during an attack of renal colic. This phenomenon may be the result of a stone in the kidney or ureter a hydronephrosis or there may be no cause for the colic which can be discovered in the upper urinary tract. This last group of cases rarely includes women and is usually associated with a latent infection involving the bladder neck and posterior urethra or the prostate. The last site of the infection probably explains the high incidence affecting the male.

In all the above groups the circumstances of the attack generally suggest that the symptoms are due to a flaring up of an inflammatory focus. On the other hand there is reason to believe that with a stone in the lower end of the ureter the frequency of micturition may be a reflex manifestation.

### URGENT MICTURITION

Urgent micturition is manifested by the necessity to pass water as soon as the impulse to do so arises. The desire to micturate may occur spontaneously in response to movement or to some quite different stimulus such as the sound of running water.

The urge is so imperative that at once a few drops of urine begin to escape or there is such an uncontrollable rush of water that it amounts to false incontinence of urine. During sleep enuresis may result. The condition is the outcome of irritability of the bladder neck. It is met with in cystitis vesical calculus urethritis and prostatitis. In the last condition only a small area of congestion may produce it. In certain cases of hypertrophy of the prostate the urgency is due to the presence of some degree of inflammation in the gland. It is also observed in cases suffering from nervous dyspepsia in whom there is also polyuria especially after meals.

### INFREQUENT MICTURITION

There are certain individuals—women more commonly than men—who regularly hold their water without discomfort for unusually long periods for example for twelve to even twenty four hours and are then able to micturate with ease and without discomfort. The practice probably depends upon the cultivated habit of abstaining from urination for progressively longer periods. There is the undoubted danger however that the prolonged retention will cause a gradual deterioration in the muscular tone of the bladder. Such a change in due course is likely to lead to even greater intervals between the urinations until complete retention of urine supervenes.

When an absence of any desire to pass water is a feature of the case, then a lesion of the nervous system is the likely cause of the condition.

Infants and young children, especially males who have been circumcised, may suddenly develop the habit of retention for long periods, which may continue for twelve hours or more. The condition is dependent upon an inflammatory condition of the urethra which is often apparent on inspecting the external urinary meatus. The retention becomes painful and generally relieves itself in due course.

**Treatment**—In children this should include bathing away any crust which may be present over the external urinary meatus, holding the child over a chamber of hot water, and placing a hot fomentation on the suprapubic region, rarely, catheterization is required.

In adults it is important to impress upon the patient the necessity for emptying the bladder every four hours or so. If atony of the bladder has already supervened, indwelling catheter or even suprapubic drainage may be necessary for a period.

### DIFFICULT MICTURITION

The term means that an unusual effort is needed to pass water. The difficulty may manifest itself in a number of different ways.

**Difficulty throughout micturition**—The stream comes without force and is small and crooked. Straining is necessary throughout the act and the patient may have to take up a special position such as lying, sitting, crouching, bending forward, or lifting one leg. The prolonged and repeated efforts give rise to hernia, piles and rectal prolapse.

The following causes may result in the above type of difficulty.

**INTERFERENCE WITH NERVE SUPPLY**, as in trauma or disease of the spinal cord, for example in spinal injury or tabes, or from a peripheral nerve lesion such as that due to syphilis or alcohol.

**THE STAMMERING BLADDER** in which the stream comes in interrupted jets due to irregular vesical contractions. The condition may be considered a neurasthenic manifestation.

**A MECHANICAL OBSTRUCTION TO THE OUTFLOW**—Into this category go prostatic obstruction, bladder neck obstruction, urethral stricture, foreign body and calculus in the urethra and sometimes vesical calculus, certain congenital lesions such as hypertrophy of the bladder neck, and vesical diverticulum.

**Delay in commencing micturition**—The patient may have to wait several minutes before the stream starts. Once it commences it continues with either a normal or only a slightly diminished flow. *Cases of prostatic obstruction* specially show this type of difficulty. It is on getting up in the morning that it is particularly noticed, for at this time the prostate is likely to be somewhat congested. Such patients may completely fail on the first attempt, but after remaining upright and attending to other matters for a few minutes are generally able to pass water without difficulty. In other cases several attempts are necessary.

**Nervous people**—It is a well known phenomenon that certain people cannot micturate in public urinals before others. This nervous disability is occasionally encountered in the consulting room.

**A further call at the end of micturition**—This obliges the patient to make a further effort to express the last few drops of urine. This effort, which is more or less involuntary, is always painful. *Cystitis* is the commonest cause

of this *vesical calculus* is less commonly present. When there is acute cystitis a little blood may be expressed with the last drops of urine.

**Interruption of stream**—This may be quite transitory and disappear as unexpectedly as it came or it may respond to a change of position. On the other hand the symptom may be permanent. A stone coming against the vesical orifice may be responsible and the state of affairs rectified by a change of position by the patient. As a rule however the symptom is due to a *spasm resulting from pain while micturition is proceeding*.

**Micturition in two attempts**—Sometimes the patient will feel that micturition is finished but soon after will again have the call and again pass a large quantity of water. Such a circumstance might be created by a *vesical diverticulum*, a pronounced *interureteric bar* or *marked dilatation of the upper urinary tract*.

**Summary**—By taking note of the special features connected with the act of micturition it may be possible for the surgeon to make up his mind provisionally as to the cause of the patient's difficulty. For example generally speaking patients who have difficult micturition from cystitis or such spinal trouble as tabes pass their water more comfortably while crouching. Stricture cases and neurasthenics tend to choose the upright posture while leaning forward, cases with difficulty from vesical calculus are most at their ease in micturating while lying down.

### RETENTION OF URINE

Retention of urine may be said to exist whenever there is urine in the bladder which cannot be expelled. It is important to distinguish two forms of retention—complete and incomplete.

**Complete retention**—In this state the patient can pass no urine at all. The retention may occur suddenly in a subject who has had little or no previous urinary trouble. Such circumstances justify the term *complete acute retention*. On the other hand the crisis may be the termination of a period of difficult micturition during which emptying of the bladder has been incomplete even requiring catheterization from time to time. The latter course of events calls for the term *complete chronic retention*. This term is equally applicable to any case of complete retention which remains permanently in this state no matter whether the retention supervened quickly or slowly.

When complete retention supervenes acutely the urge to micturate occurs with increasing frequency and is soon accompanied by pain which often develops to an extreme degree as involuntary bladder contractions gradually replace the voluntary efforts. At the same time there is a constant pain in the suprapubic region from the unaccustomed and increasing bladder tension. Repeated attempts to micturate result at the most in the passage of a few drops of urine. As the condition remains unrelieved the distended bladder soon becomes palpable and tender or even visible as a swelling in the suprapubic region.

At this stage the general condition of the patient may or may not be grave. If the situation is not resolved by catheterization the intravesical pressure may be such as to overcome the obstacle and cause the escape of enough urine to give some relief to the patient's suffering. Only exceptionally does the bladder rupture from the distension an accident which will quickly lead to the death of the patient if not promptly recognized and dealt with. More usually the unrelieved case suffers increasing distress falls into a coma and dies from the intoxication which inevitably supervenes. After relief by



catheterization, once or on more occasions, normal micturition may return. If it does not then the patient is in a state of complete chronic retention.

**DIAGNOSIS—Of the existence of retention—**Anuria is the one important condition which has to be excluded in the differential diagnosis. Except with paralysed bladders there is the urge to pass water with acute retention, this desire is quite absent in anuria so also is the palpable suprapubic swelling. Finally catheterization shows the bladder to be empty.

**Of the cause of retention—**The pathology of retention is often complex, so much so that even when an obstacle to the outflow is clearly identified it is not always certain to what extent the retention is due to inhibition of the vesical musculature and contraction of the vesical sphincter, but for practical purposes we must keep in mind a number of conditions which either directly or indirectly play a part in producing retention of urine.

The following is a classification of the causes —

#### EXTRA-URINARY CONDITIONS

Lesions of the central nervous system, hysteria, after operations, peritonitis, spinal anæsthesia

#### AFFECTIONS OF THE URINARY TRACT

Traumatism of the bladder or urethra compression of the bladder or urethra by blood, pus, urine, tumours or gauze packing in the rectum, obstruction of the urethra by stone, foreign body, new growth or blood clot, inflammatory lesions of the bladder, prostate or urethra, congestion of the prostate or urethra after instrumentation or repeated coitus, urethral stricture, hypertrophy or malignant disease of the prostate, contraction of the internal urinary meatus, post-prostatectomy obstruction, bladder diverticulum, reflex renal lesions especially in tuberculosis

#### PRE EXISTING DISEASE INDICATES DIAGNOSIS

From the above list may be chosen a number of instances in which the cause of the retention will be easy to recognize, for example following a traumatism or an operation in the course of an attack of gonorrhœa, complicating a urethral stricture where one is known to exist, or a periurethral condition such as abscess or extravasation. Peritonitis in the true pelvis can complicate severe retention of urine especially when there is paralysis of the bladder.

#### EXPLORATION

In an elderly man rectal examination may reveal hypertrophy or carcinoma of the prostate. If not it should not be forgotten that urethral stricture is not unlikely to be present in such a case, and that the gentle passage of instruments will decide this point. A young man with retention giving a history of gonorrhœa is probably suffering from stricture, and this matter can be detected quickly by the passage of bougies. A bimanual pelvic examination in women will generally clear up the question of a pelvic tumour as a cause of the retention. A careful rectal examination in the male may reveal

such a condition. Palpation of the urethra combined with a rectal examination may be all that is necessary to establish the presence of a foreign body or a stone in the urethra.

In an elderly man where neither rectal examination nor urethral exploration has revealed the cause of the retention cystoscopy will generally be necessary to decide whether there is not an adenomatous intravesical projection of the prostate causing the retention.

In younger subjects it may be necessary to carry out urethroscopy to settle the question of the presence of a new growth of the urethra or cystoscopy may be required to decide whether or not a vesical diverticulum is present for the latter abnormality is sometimes associated with retention of urine. A small adenoma at the vesical neck is sometimes found in this group of patients. Failing any of these causes a reflex retention of urine from renal tuberculousis can be carefully gone into on this occasion.

**Incomplete retention**—This implies the inability to completely empty the bladder.

**TWO TYPES OF INCOMPLETE RETENTION**—Broadly speaking two degrees may be recognized—incomplete retention without distension incomplete retention with distension. In the former the amount of residual urine is not large while in the latter the bladder remains constantly distended in spite of the patient's inability to pass water. In both groups the patient is at all times unaware that the bladder is never emptied.

**THE SYMPTOMS** vary according to the case. *Increased frequency of micturition*—Even though the urine is perfectly clear this is invariably present and is more marked during the night. It is due to two facts that the diminished capacity of the bladder causes it to fill more rapidly the retention produces polyuria.

*Urgency of micturition and nocturnal incontinence*—These are often additional features. A few drops of urine escape immediately the desire to micturate occurs. During the night this symptom is exaggerated and may take the form of true incontinence. In the latter circumstances distension is generally a prominent feature.

*Retention with overflow*—As the condition progresses the bladder tends to become grossly distended and generally visibly distends the lower abdomen and the urine escapes continuously drop by drop. This state of affairs is inevitably accompanied by dilatation of the ureters and kidneys as a result of back pressure which first of all causes dilatation of the ureteric orifices. The general condition of the patient at this stage begins to fail from the developing toxæmia.

*Signs of intoxication*—Sometimes it is not the urinary symptoms but general signs of the toxæmia which attract attention or the two groups of symptoms may progress together. Digestive disturbances in the form of loss of appetite nausea a tendency to vomit occasionally, flatulence constipation a loss of power of concentration and a tendency to sleep a lot are common enough symptoms in this type of case. At the same time the patient may notice an increase in girth due to protrusion of the lower abdomen in this region there may be a complaint of a sense of weight.

*Incomplete acute retention*—This is a sequel only in exceptional cases but when it does occur the patient is seized with spasms of pain which compel him to endeavour to micturate when he is able to relieve himself to some extent as a result of protracted efforts.

**DIAGNOSIS**—*Diagnosis of the existence of incomplete retention*—If the significance of the preceding clinical types is not understood, the question

of retention of urine might quite easily be overlooked and if the patient is passing water freely and in abundance and is in no distress he might even resent any exploration to determine the point

*Incomplete retention* must be thought of when pollakiuria is present equally both day and night without evidence of cystitis also in post operative cases who complain of a sense of weight in the lower abdomen If distension is present palpation will identify the rounded swelling in the mid line of the suprapubic region in spite of the fact that the patient has recently passed water A less marked degree of retention may be identified with combined rectal and abdominal palpation

When in doubt an intravenous cystogram should be taken immediately after micturition The passage of a catheter immediately after the patient has passed water will determine the presence and the quantity of residual urine but is not always expedient

*Diagnosis of the cause of incomplete retention*—In the case of a distended bladder which is easily palpable the same causes will need to be considered and the same procedures followed as laid down under the heading *Diagnosis of the Cause of Complete Retention*

With an undistended bladder the existence of residual urine will be determined either by manual examination as already described by catheterization or by a cystogram during intravenous urography The same consideration will then be given to possible predisposing causes as indicated above It commonly happens that cystoscopy and sometimes urethroscopy is necessary before the cause can be stated with certainty It may be stated that in the great majority of cases that fall into this category the cause of the retention is some change at the bladder neck generally prostatic or in other glands in this vicinity

### INCONTINENCE OF URINE

This term is applied to the involuntary escape of urine from the bladder by way of the urethra Sometimes the water runs away continuously at other times there is an intermittent discharge of a large quantity while between these occasions the patient is able to hold the urine and also to pass it normally as necessity arises The incontinence of infants must be looked upon as a normal state

Sometimes the incontinence is preceded by retention of urine which has distended the bladder In such a case the intravesical pressure rises sufficiently to force the obstacle causing the retention This is incontinence with overflow and leads to a soiling of the clothes a permanent odour of urine about the patient and often skin irritation

*Ætiology*—A CLASSIFICATION OF THE CAUSES OF INCONTINENCE —

*Incontinence without apparent lesion of the urinary tract*

- (a) With lesions of the central nervous system
- (b) In nervous states hysteria neurasthenia
- (c) Essential enuresis

*Incontinence with lesions of the urinary tract*

- (a) From bladder lesions inflammation especially tuberculous contracted bladder stone or foreign body new growth fistulæ
- (b) From prostatic and bladder neck lesions simple or malignant enlargement of the prostate after prostatectomy after trans urethral resection of prostate or bladder neck inflammation of the bladder neck

- (c) From urethral lesions *traumatism, inflammation stone or foreign body, new growth urethral stricture weak sphincter control in females resulting from childbirth*

*Incontinence—with or without urinary tract lesion—with overflow*

This occurs from time to time in the following —

- (a) Disease or injury of the central nervous system
- (b) Prostatic or bladder neck obstruction
- (c) Urethral stricture

**Diagnosis**—True incontinence must be distinguished from *false incontinence*. The latter occurs in cystitis in which there are involuntary escapes of urine resulting from urgency. It also occurs in certain cases of overflow. These cases of false incontinence may in time become cases of true incontinence. For example, with cystitis the bladder may become so intolerant that it will hold no urine at all while in obstruction cases the bladder neck may be forced. In cases of stricture, and of inflammation localized to the posterior urethra and the bladder neck there is often an involuntary escape of a few drops of urine at the end of micturition.

*Fistulae* between the ureter or bladder and the vagina must not be mistaken for true incontinence of urine.

In some women incontinence may occur in the erect posture, sometimes with and sometimes without, a muscular effort on the part of the patient. The commonest cause of this type of case is damage to the vesical sphincter as a result of childbirth. This may not be evident till some years after confinement, in which case the ultimate development of stress incontinence seems to depend on a gradual increase of uterine prolapse and vesico vaginal displacement. *Stress incontinence* also sometimes occurs in nulliparous women. In these cases the initiating cause is inflammation, which is marked in the posterior urethra and at the bladder neck. Often the uterine cervix is the seat of an erosion as well.

*Ectopic opening of a ureter* into the urethra, vulvæ, or vagina causes a continual escape of urine, which is, however, accompanied by normal micturition as well. The incontinence always dates from birth. The ectopic opening will be readily discovered on careful inspection.

In a child with *enuresis* one must not be too ready to assume that the case is one of essential enuresis without making a thorough investigation. Many cases have an inflammatory focus in the posterior urethra and sometimes of the external urinary meatus and, in the female, of the vulvæ as well. More rarely renal tuberculosis or vesical calculus may produce the symptom.

Following a pelvic operation the circumstances generally indicate that the incontinence is due to fistula from a ureter or the bladder.

*Inefficiency of the vesical sphincter* in a woman is established by noting that the incontinence is only present, or more pronounced, in the upright position and by inspecting the vulvæ. On asking the patient to strain, the vesico vaginal displacement and the escape of urine will be seen.

A pelvic tumour pressing on the bladder may be the cause of the incontinence, a bimanual examination per vaginam or per rectum should identify the reason.

In spinal cases and other paralytics there is often retention with fever and overflow incontinence. The identification of the state of affairs is not difficult to establish.

With a *urethral stricture* the incontinence is at first diurnal and later nocturnal as well. The onset of the incontinence corresponds with the presence

of a good deal of residual urine in the bladder, as this increases, the incontinence instead of being intermittent may be continuous, the urine escaping drop by drop. The history and a urethral exploration will give the clue to the cause of the condition.

In adolescents and young adults with nocturnal incontinence there is generally diurnal frequency of micturition as well. A posterior urethroscopy will commonly show inflammatory changes in both sexes. In females there is sometimes a chronic inflammatory state of a pelvic extra urinary organ. There is sometimes residual urine and less usually a contraction of the internal urinary meatus.

In more elderly men overflow incontinence from prostatic obstruction will always be kept prominently in mind as a likely state of affairs. The presence of the distended bladder and the findings on rectal examination will usually make the position clear. In certain rare cases there is no distension of the bladder, but the prostatic changes have resulted in such alterations of the internal urinary meatus that it ceases to function as an efficient sphincter.

When rectal examination does not indicate that the prostate is the cause of the trouble, it should be remembered that no patient is too old to have a urethral stricture. If investigations prove that this cause does not exist then in due course the question of an intravesical projection of the prostate or a generalized contraction of the internal urinary meatus must be settled by cystoscopy, or when the bladder is opened if this procedure becomes necessary.

In long standing cystitis, especially in tuberculosis cases, incontinence may result from chronic contraction of the whole bladder, or from destruction of the bladder neck. Both states show a small bladder by intravenous urography, and an incapacity of the bladder to hold more than a small quantity of fluid when this is injected per urethram. Cystoscopy under general or spinal anesthesia will generally be necessary to distinguish between the two conditions.

There may be indications that some pathological condition existing in the urethra is the cause of the symptom. Urethroscopy is called for in this case, especially when the question of calculus or foreign body requires to be fully investigated.

Incontinence during an epileptic seizure requires no further explanation, while incontinence from hysteria or neurasthenia may be considered a rare occurrence.

Finally it may be said that if a thorough search has been made and that this search includes the posterior urethra very few cases indeed of enuresis will remain for which a cause cannot be found.

In cases of recent onset the commencement of renal tuberculosis must be thought of and investigated.

### INCONTINENCE OF URINE IN CHILDHOOD

There is no doubt that the term "essential incontinence" which is sometimes used for this condition is an unsuitable term, because a cause can so often be found which when treated, commonly results in an abatement if not a disappearance of the symptoms.

With regard to the mode of onset the cases are about equally divided into two types: those that continue from infancy, those that commence some time after the involuntary micturition of early childhood has ceased. In many cases involuntary micturition has ceased for months or even years before enuresis supervenes.

In the course of time the enuresis tends to disappear spontaneously, generally after some years have elapsed. In most cases the complaint has cleared up by puberty. In others it drags on through adolescence in some until the age of 20. A few cases continue well on into adult life. Most of the older patients suffer from diurnal frequency as well. Although some of the patients manifest excitability of temperament the majority seem quite normal in this respect. Commonly several children of the same family suffer from the complaint.

**Ætiology**—Numerous causes have been set out for this complaint and in many of these the possibility of cause and effect often cannot be denied yet the results of treatment frequently fail to establish the fact that there has been any connection between the two conditions.

**EPILEPSY**—Although this is an uncommon cause of enuresis yet enuresis is fairly common with epileptics. The morning after wetting the bed the child appears dull mentally, complains of headache and may have difficulty in speaking if the tongue has been bitten.

**PSYCHIC AND OTHER CEREBRAL INFLUENCES**—These are most important (see Pathogenesis).

Mental instability has its influence when the two conditions are associated.

**VARIOUS PATHOLOGICAL CONDITIONS OUTSIDE OF THE URINARY TRACT**—There is quite a long list of these. In some cases the association between the two conditions is proved by the effect on the enuresis of dealing with the pathological state in question of which the following are the chief: enlarged tonsils, adenoids, impetigo, rectal polypus, intestinal parasites. It must be said however that in the majority of cases after carrying out the necessary procedures there is no benefit to the enuresis. One must therefore be guarded in assigning importance to these factors in an ætiological sense.

**SPINA BIFIDA OCCULTA**—This occurs in the sacral region and can only be diagnosed by radiography. It is said that in this condition there is a fibrous or fibro cartilaginous band which compresses the dura mater and that this state of affairs gives rise to incontinence of urine. Good results have been claimed for freeing this band by operation but these are not constant. It is indeed a grave responsibility to advise such a serious operation for so uncertain a result. There are two facts which lead to the conclusion that the spina bifida is generally unimportant: when spina bifida and organic disease of the urinary tract are both present the enuresis often clears up after treating the latter condition; cases of spina bifida are observed in which no incontinence is present.

**INFLAMMATION OF THE GENITALS AND THE LOWER URINARY TRACT**—Small localized inflammatory states about the external genitals which ultimately come to involve the urethra tend to be very chronic in children, are apt to be overlooked and are commonly associated with enuresis.

**IN THE FEMALE**—*Vulvitis* (Fig. 125) is quite common in this respect. It may be localized to the crypts which are sometimes present on the vestibule and those which lie in the crevices between the labia minora and the hymen. The external urinary meatus is invariably involved and where urethroscopy is possible the urethra will be found to be implicated in the inflammation as well. Some of the vulvitis cases undoubtedly continue for many months and the worst cases even for several years. It may be expected therefore that the accompanying inflammation of the urethra and sometimes even of the bladder neck may also tend to be chronic and to render the reflex of micturition somewhat more sensitive than normal.

*Adhesions* involving the clitoris or sealing the labia minora together are

other inflammatory manifestations. There may be a mass of smegma retained under the prepuce of the clitoris. Less commonly in female children the *cervix uteri* is the seat of an inflammatory state. This structure can be quite conveniently inspected through a vaginoscope without causing any damage to the hymen. The cervical change is invariably associated with urethral and bladder neck inflammation. A simple vaginitis is sometimes present.

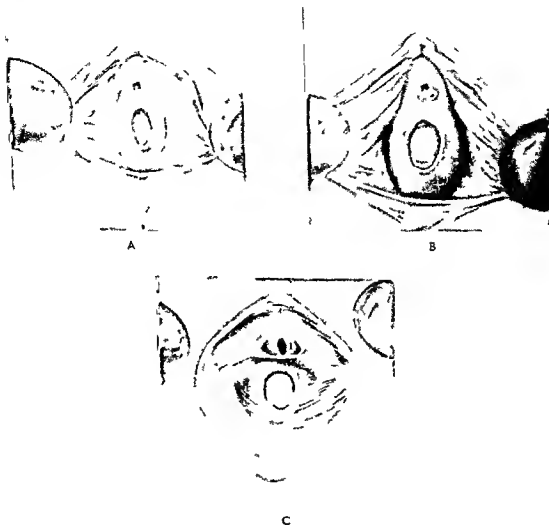


FIG 125

Vulvitis in children. A, Normal vulva; B, Mild chronic vulvitis; C, Generalized vulvitis. Note that the vaginal mucosa is not involved.

**IN THE MALE**—In uncircumcised children there is the occasional case of *balanitis*, this is sometimes present even when the foreskin is easily retracted.

*Adherent foreskin* is a most important factor because of the retained smegma which often results. The involvement of the urethra from this is apparent at the external urinary meatus which becomes surrounded by oedema (figs 126, 127 and 128).

In circumcised children inflammation of the external urinary meatus is not uncommonly seen. It is generally referred to as *meatitis*, of which

there are several degrees (Figs 129 and 130) hyperemia of the mucosa behind the meatus, ulcerations of the mental margins ulceration of the mental margins with an overlying crust



FIG 126

Two views of oedema of external urinary meatus resulting from adherent prepuce and retained smegma in a child aged 6 years



FIG 127



FIG 128

Exposure of retained smegma after retraction of adherent prepuce

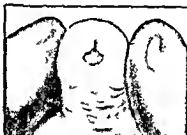


FIG 129

Ulcerative meatitis in a circumcised child aged 1 year and 3 months



FIG 130

Meatitis with scab formation in a circumcised child aged 7 months



FIG 131

Constricted external urinary meatus in a child of 1 year and 11 months

Constriction of the external urinary meatus (Fig 131) occurs fairly quickly as a complication of meatitis but the latter condition does not occur in the uncircumcised (Winsbury White 1941) Atresia also occurs as a congenital condition

*Stricture*—generally involving the penile or the bulbous urethra—is occasionally found in male children with enuresis



*Uncomplicated phimosis*—Although this can rarely be proved to be the cause of enuresis yet it is wise to regard it as a potential factor

*Hypospadias*—This is sometimes associated with a constriction of the external urinary meatus, in which case it may be regarded as a contributory cause

**IN BOTH SEXES**—It must be realized that the inflammatory conditions just discussed tend towards a chronic state. In many cases of enuresis in which there is no inflammation involving the outer aspects of the external genitals mild chronic inflammatory changes of the posterior urethra, and less frequently of the bladder neck, are to be noted nevertheless

Another condition which must receive proper attention is a *generalized narrowing of the whole urethra*

*Inelasticity of the urethra* is strikingly present at times. This is identified when urethral dilatation is attempted (see p. 279)

*Urethritis*—If the urethroscope is used systematically in children with enuresis a certain proportion of them will be found to have some degree of mild chronic inflammation present

Occasionally enuresis is due to the *relief of retention* which has resulted from inflammation at the bladder neck causing spasm

It is important to remember that the majority of enuresis cases fall into the group with the mild inflammatory changes above described

*Cystitis*—In a certain number of cases cystoscopy shows some degree of bladder inflammation, often this is scanty and in patches and is more in evidence in the younger than in the older children (Fig. 132)

**The urine**—With so called essential enuresis the urine is generally crystal-clear on inspection, and neither culture nor smear examination of the centrifugal deposit of catheter specimens reveals the presence of organisms, nor are pus cells to be found in sufficient numbers to indicate inflammation (85 per cent., Winsbury White, 1941). In this respect these findings correspond broadly to those in adult cases of mild chronic infection of the posterior urethra and the bladder neck

*Hydrogen ion concentration*—Investigation throws no additional light on the aetiology for it has been found to vary as widely as from 4.4 to 9.7 (Winsbury White, 1941)

**Pathogenesis**—There is no doubt that the act of micturition is more easily precipitated in the child than in the adult. Where the stimulus arises which causes the act to be performed, is a question which can best be decided by carefully studying individual cases. In *epilepsy* the stimulus is undoubtedly cerebral in origin, this may also be said of *hysteria*. In *highly excitable children* the same may often be true. The great majority of children that one has seen, however, are completely normal mentally and most of them highly intelligent. In older children adolescents and adults because they are acutely conscious of their affliction with all its dreaded consequences, psychopathic manifestations are to be expected, and are usually found. Stalker and Band (1946) made a psychosomatic study of 67 cases ranging in age from 12 to 39 years and found psychiatric abnormalities commonly present, although they considered these to be the cause rather than the effect. Results of treatment have shown that sometimes stimuli from such peripheral sources as the tonsils have been responsible but again treatment has also made it clear that suspicion upon such sources is generally wrongly placed

Influences from the higher centres are much more potent as stimuli for

the act of micturition in the presence of a pathological state of the urinary tract than in normal individuals. The sound of running water or an emotional disturbance is a more powerful incentive to micturate when cystitis is present than when this condition is absent and the importance of this relationship should be kept in mind when even the most unobtrusive lesions of the urinary tract are concerned the latter will be discussed in due course.

On the other hand in cases where there is profound sleep the inhibiting influence of the higher centres is probably cut off, in which circumstances local stimuli are likely to become effective.

Deep sleep is certainly a striking feature in many of these cases, and it

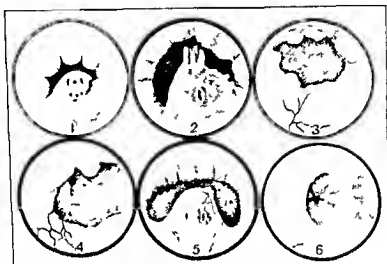


FIG 133

1 A granuloma in the left prostatic sinus several small pits present on the front of base of verumontanum (B P, 11 years, enuresis and attacks of frequency since early childhood) 2 Polyp on summit and granulomata on side of verumontanum (A B, 12 years, enuresis since early childhood) 3 Inflammatory hillocks on roof and right lateral wall of posterior urethra (see also No 6) (G H, male 17 years enuresis and daily frequency since early childhood) 4 Inflammatory hillock on roof of posterior urethra (J S, female, 13 years, enuresis since early childhood) 5 Small granuloma on verumontanum (F J, 14 years) 6 Stricture on right lateral wall of bulbous urethra and infected follicle (same as No 3)

is a fact that after instrumental treatment adolescent and young adult patients often tend to wake regularly to pass water, whereas previously waking never occurred. From these circumstances there is a strong suggestion that the profundity of the sleep is a toxic state which becomes reduced by the treatment.

The neuromuscular mechanism controlling micturition is more sensitive to stimuli, from whatever source, in children than adults, hence enuresis in children and the tendency for the complaint to disappear as the child grows older.

**Cystometry**—Cystometry has failed to show a common neuromuscular factor in enuresis cases. Campbell (1937) investigated three hundred and nine and failed to find any cases suggesting such a relationship. He made the important observation, however, that although in 24.7 per cent, cystometrograms suggestive of parasympathetic imbalance (hypertonic) were obtained, yet inflammation of the deep urethra produces similar curves.

The posterior urethra on the other hand is found to be commonly the seat of inflammation or hypertrophy in cases of so called essential enuresis. The most striking manifestations are seen as granulomata, dilated gland orifices, hillocks, polypi and cysts (Figs 133, 134 and 135). Rarely a patch of leucoplakia has been noted. Less conspicuously there may be merely hyperemia of the mucosa. The most convincing proof of the importance of posterior urethral inflammation in relation to essential enuresis is to be found in those cases which have continued from childhood well into adult life. 90 per cent of thirty such cases which I have examined showed inflammatory or hypertrophic changes in the posterior urethra. These mostly took the form of

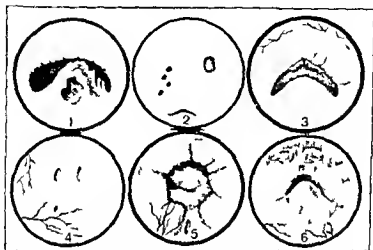


FIG 134

- 1 The changes involve the sinus pudendus, the verumontanum and the left prostatic sinus (S. H. 8 years, meatitis at age of 1 year).  
 2 Gland orifices on roof of membranous urethra dilated from past inflammation (same case as No. 1). 3 Filamentous inflammatory projections on roof of membranous urethra (H. M. 14 years, a male with enuresis). 4 Gland orifices dilated from chronic inflammation on roof of membranous urethra (V. B. female, 1 year, 9 months, frequency, urgency and dysuria). 5 One of two adventitious gland orifices in posterior urethra is seen in the photograph (J. W. female, 6 years, with enuresis). 6 Tags of necrosed inflammatory tissue on roof of membranous urethra and on verumontanum (A. H. 44 years, enuresis for many years, 4 oz residual urine).

well developed hillocks, granulomata or polypi (Fig. 136 (Nos. 1, 2 and 3)). Often fibrotic changes are present. Moreover I have found that urethral pathology is well marked as a rule in cases where the enuresis begins in adolescents or young adults. In all groups the bulbous and membranous urethra are commonly involved.

When the above changes are present such an important source of stimuli cannot be disregarded. That urethral stimuli can precipitate the act of micturition has been shown experimentally by Barrington (p. 232). The association becomes all the more interesting when treatment of the posterior urethra gives a satisfactory response—as it so often does—in the subsequent course of the enuresis. Taking a broader view of the relationship of urethral changes to enuresis, one is impressed with the high proportion of these cases that suffer from daily frequency of micturition as well as from enuresis. Moreover, in many cases of children suffering from chronic frequency but not

the act of micturition in the presence of a pathological state of the urinary tract than in normal individuals. The sound of running water or an emotional disturbance is a more powerful incentive to micturate when cystitis is present than when this condition is absent and the importance of this relationship should be kept in mind when even the most unobtrusive lesions of the urinary tract are concerned the latter will be discussed in due course.

On the other hand in cases where there is profound sleep the inhibiting influence of the higher centres is probably cut off in which circumstances local stimuli are likely to become effective.

Deep sleep is certainly a striking feature in many of these cases and it

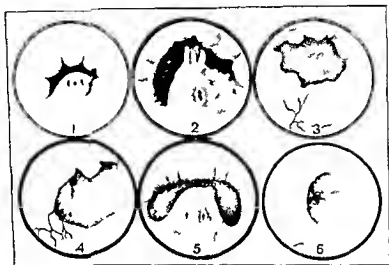


FIG 133

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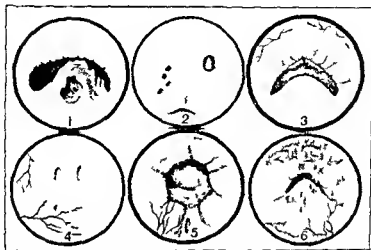


FIG 134

- 1 The changes involve the sinus pocularis the verumontanum and the left prostatic sinus (S. H. 8 years meatitis at age of 2 years)
- 2 Gland orifices on roof of membranous urethra dilated from past inflammation (same case as No. 1)
- 3 Filamentous inflammatory projections on roof of membranous urethra (K. M. 14 years a male with enuresis)
- 4 Gland orifices dilated from chronic inflammation on roof of membranous urethra (M. B. female 2 years 9 months frequency urgency and dysuria)
- 5 One of two adventitious gland orifices in posterior urethra is seen in the photograph (J. B. female 6 years with enuresis)
- 6 Tags of necrosed inflammatory tissue on roof of membranous urethra and on verumontanum (A. H. 44 years enuresis for many years 4 oz residual urine)

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from enuresis I have found the same pathological changes in the urethra as noted in the enuresis cases. A small proportion of the latter give a history of onset following one of the exanthemata or some other inflammatory disease. Others (Folsom 1935 Campbell 1935 Spence and Moore 1939) have also

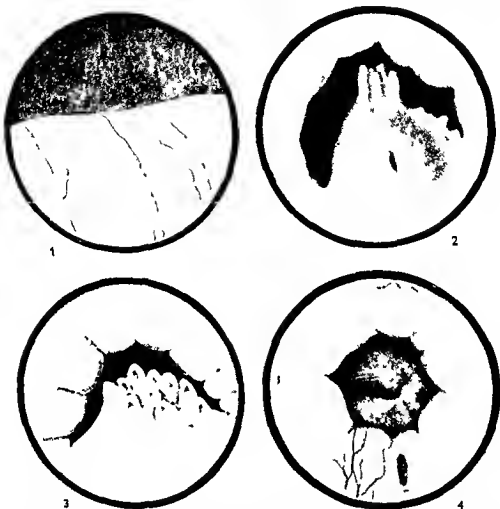


FIG. 135.

Drawings made in enuresis cases during urethroscopy—the first instrumentation. In none of the following cases did the laboratory report on the urine give any indication that infection was present in the urinary tract. 1 The floor of the posterior urethra adjacent to the internal urinary meatus completely normal (see No. 2). 2 Polyps on summit and granulomata on side of verumontanum from same case as No. 1 (A. B., 12 years, enuresis from early childhood). 3 Collection of polyps on verumontanum (J. S., 18 years, enuresis and frequency since early childhood). 4 Generalized inflammation in posterior urethra. One of two adventitious gland orifices is seen. There was also inflammation of the bladder localized to the front of the trigone urethral trigonitis (J. W. female 6 years, bed wetting since infancy).

called attention to a relationship between enuresis and inflammation of the posterior urethra in children.

A number of facts, however, have combined to distract attention from the urethra as the origin of the trouble—the absence from the urine of signs of inflammation, failure to examine the external genitals, especially of the female, failure to examine the urethra. Because of a lack of an obvious reason for the existence of the disability there is apt to be a tendency to regard

most cases as due to psychological influences. There is a special danger of this where the child is easily excitable or very nervous.

When cystitis is present invariably the inflammation involves the base of the bladder, where it often appears only as small and insignificant patches of hyperemia or petechiae which might at times escape notice. Sometimes the inflammation on the trigone is confined to the vicinity of the internal urinary meatus, through which the hyperemia often extends into the posterior urethra (urethritrigonitis), but in the latter locality granulomata may be seen while the front of the trigone remains completely normal. In a few cases

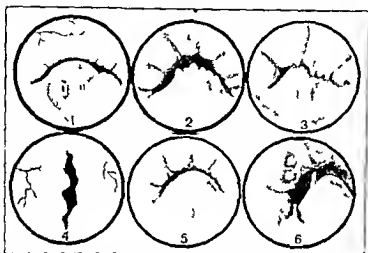


FIG 136

- 1 Large granuloma in left prostatic sinus (D H 27 years enuresis since age of 7 years residual urine 9 oz)
- 2 Collection of polypi on verumontanum (E S 18 years enuresis and frequency since early childhood)
- 3 Widespread inflammatory lesions in posterior urethra in region of verumontanum (A C 32 years enuresis since early childhood)
- 4 Hypertrophic hillocks on right lateral wall of posterior urethra (F S 20 years male enuresis for 2 years)
- 5 Recent looking inflammatory lesions on front of verumontanum (R P 22 years enuresis and frequency for 2 months residual urine 3½ oz)
- 6 Polypi on verumontanum and inflammatory patches on wall of posterior urethra (H B 35 years enuresis for 4 years)

the cystitis is fairly widespread—exceptionally the mucosa of the whole bladder is involved.

The important fact to bear in mind about cerebral stimuli is that they are more potent when there is a local factor as well which will act as a stimulus. For example it is found in some adult patients who suffer from frequency and urgency because of bladder neck or posterior urethral irritation that emotional, visual and auditory stimuli precipitate an urge to micturate which did not occur before the local changes gave rise to symptoms.

That there is sometimes a certain degree of renal derangement in these cases is apparent as follows—evidence of reduced renal function or the presence of mild dilatation of the ureter pelvis or calyces, as indicated by excretion urography (60 per cent Wmsbury White 1941) and polyuria. One of the facts which puzzle many parents is where all the water comes from for on occasions the child is found to be literally soaked from head to foot.

**Diagnosis**—Epilepsy and hysteria will be excluded by taking a careful

history The danger of confusing the uninterrupted incontinence resulting from the ectopic position of a ureter will be avoided in the same way and by the subsequent examination A report on the urine is essential for evidence of nephritis, glycosuria and a urinary tract infection, if the last is present an intravenous urogram will usefully be the next step A general anæsthetic may be necessary for this procedure The films may reveal an important degree of dilatation involving a part or the whole of the urinary tract, in this event future attention will be directed to dealing with this For example, a unilateral hydronephrosis will generally require nephrectomy Such intervention apart from ridding the patient of an important disease, offers every prospect of curing the enuresis

If up to this stage the investigations have yielded negative or uncertain results an examination under an anæsthetic should be carried out In arranging for this it is wise to have permission to carry out any necessary treatment at the same time

The child should be encouraged to pass water immediately before the anæsthetic is administered so that the residual urine can be tested Micturition is most likely to occur on this occasion if the pre operative injection consists of atropine only

The examination is conveniently commenced in the dorsal decubitus In the female the vulvæ should be inspected, and if any vaginal discharge is present the cervix should be examined through a vaginoscope A cervical erosion can be cured by one treatment of gentle dilatation and cauterization with a diathermy or a Pacquelin's cautery In the male, before passing any urethral instruments, it may be necessary to carry out meatotomy

It is wise at this stage to test the calibre of the urethra according to age, noting the largest size of sound that lies in the urethra without being gripped The scale in this respect is roughly as follows —

Aoe (Years)	Size (Charrere)
2	10
4	12
6	14
8	16
10	18
12	20
14	22

Some very interesting variations are to be noted by paying attention to these measurements In exceptional cases a urethral stricture is detected by this procedure

Cysto urethroscopy should next be carried out The child's buttocks are supported on a sand-bag As soon as the instrument is passed, observation is made for the presence of residual urine which is measured if present When a cystoscope only is available the bladder neck can be more satisfactorily inspected by raising the child's lower limbs till the lithotomy position is assumed, in this position even the posterior urethra can be examined to some extent with the cystoscope

For the use of the urethroscope the supine position is maintained Although a cysto urethroscope is a convenient instrument for the double examination, a better view of the posterior urethra is undoubtedly obtained through a direct vision urethroscope of the Geiringer type (Fig 228)

Treatment—URETHRAL CONDITIONS.—As the child is under an anæsthetic,



treatment should proceed at once after the examination is completed. There are several conditions any one of which may be discovered during the investigations just enumerated in cases of enuresis which yield good results when treated by intermittent dilatation of the urethra. These are generalized urethral contraction, urethral stricture, small amounts of residual urine in the bladder and chronic inflammatory foci in the posterior urethra. The last of these is by far the most common in boys. In male children meatitis and constriction of the external urinary meatus should be treated in the same way after meatotomy has been carried out. The beneficial effect from urethral dilatation results from the improvement in drainage from any urethral glands which happen to be infected and other foci of infection.

In young male children it is important not to attempt the dilatation with the metal sounds meant for adult males. These are dangerous principally because the curves are too large. If gum elastic bougies are used these should be well softened in hot water before use. It is much more satisfactory however to carry out this treatment with a set of metal sounds made specially for children (Fig 137). Alternatively the straight metal anterior urethral dilators meant for adult males will do perfectly well. Coarsely graded instruments are dangerous. Commencing with the appropriate size according to the age of the child the dilatation is continued with successive sizes until the limit of dilatation is attained. This point varies with individuals

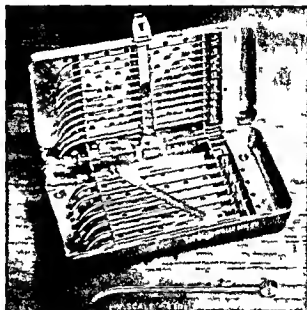


FIG 137

Set of child's urethral dilators (Windsbury White pattern)

and especially in males the operator must learn from experience when this limit is reached. The female urethra is more dilatable than the male.

In the male the following extremes of dilatability of the urethra were noted in my enuresis cases —

Age of patient (Years)	Lowest dilatability (Charrriere)	Highest dilatability (Charrriere)
5	14	18
9	17	21
13	21	25

The lack of elasticity which is sometimes noted is probably due to fibrosis in such cases the enuresis responds well to dilatation.

In male children it may be found that as the dilatation proceeds the external urinary meatus grips the instrument tightly. If this happens meatotomy must be carried out forthwith otherwise bruising of the meatus and a subsequent stricture may occur.

Occasionally after a single treatment the enuresis ceases permanently, but as a rule the treatment requires to be repeated a number of times

If full co-operation is obtained from all concerned, practically all properly chosen cases will benefit to some extent as a result of this line of treatment, but it is better not to embark upon it if it is to be abandoned before completion. The interval which should elapse between the first two treatments should not be less than two months. I think this is the best interval, because I have known cases which showed no improvement at all for the first four weeks and then were suddenly and dramatically cured or improved. Succeeding intervals should be at two, three or six months, according to indications in individual cases. Where urethral fibrosis or stricture is present it may be necessary to carry out several of the early dilatations at monthly intervals.

It should be hardly necessary to emphasize the fact that where no urethral pathology exists urethral dilatation is not indicated, in such circumstances there is certainly no response to this treatment. Nor will it be effective when well developed urethral polypi are present. These will require to be destroyed by fulguration.

I have found from experience that there are certain points which must receive the strictest attention if good results are to be expected from treatment by urethral dilatation.

(1) As the dilatations so often have to be repeated it is wise to make this perfectly clear at the outset especially in private practice. It is better not to commence the treatment unless repeated treatments are agreed upon in the first instance.

(2) Urethroscopy and cystoscopy should be carried out before deciding treatment.

(3) No benefit need be expected when the dilatations are carried out at short intervals, two months should be the shortest period between two treatments, unless a stricture or a generalized urethral contraction be present.

(4) Although too frequent dilatation is harmful, the prolongation of an individual treatment by the use of an indwelling catheter for half an hour or so, with removal of the catheter before the patient awakens from the anæsthetic, can be employed with advantage in certain difficult cases.

(5) It must be kept in mind that some urethræ have but a small capacity for dilatation.

(6) Over dilatation must be avoided, it will certainly make the patient worse.

(7) It may be necessary to repeat the dilatation several times before any important change for the better occurs.

(8) Chronic frequency of micturition when present usually improves quickly from dilatation.

(9) For dilatation to be successful, meatotomy will be necessary in a large proportion of male cases. It is harmful to the patient to attempt urethral dilatation through an inadequate external meatus.

(10) The treatment must not be given during a flare-up, of frequency of micturition, or of any acute local inflammation, disregard of this rule will make matters worse.

(11) The presence of a catarrhal condition in the respiratory, alimentary or urinary tracts, when the treatment is carried out, or soon after, will result in failure or relapse. In the younger patients with whom these infections occur so commonly, it is often wise to postpone treatment for several months, especially during the winter.

(12) Fulguration of urethral polyp in children is necessary on only rare occasions

**MEATOTOMY**—This is an important little operation in connection with enuresis, and is applied to the enlargement by incision of the external urinary meatus in the male. A pair of pointed scissors should be used, one blade is inserted into the meatus and a cut is made to one side of and parallel with the frenum down to the level of the coronal sulcus. The moment the cut is made the two raw surfaces are pressed together with the thumb and forefinger and pressure is thus maintained for one minute, at the end of this time bleeding should be completely under control. No sutures are required. Dilatation of the urethra is then carried out. A few inches of  $\frac{1}{2}$ -in ribbon gauze soaked in sterilized liquid paraffin should then be packed into the navicular fossa. The outer free end of the gauze is wound round the penis behind the coronal sulcus and over the foreskin if one is present. The gauze serves the double purpose of controlling bleeding and keeping the raw surfaces apart. It should be removed when the patient first needs to pass water. The meatotomy wound must be carefully supervised daily for the next five days. This entails gently separating the cut surfaces throughout their whole length. This may be accomplished either with sinus forceps or by inserting the tip of a sound.

**OTHER CONDITIONS IN THE URINARY TRACT**—*Phimosis* should always be dealt with by circumcision or dorsal slit. Restraint should always be exercised in promising what the effect of these measures will be on the enuresis.

Evidence of *nephritis* will call for measures directed towards lessening the work of the kidneys.

*Glycosuria* must receive appropriate treatment.

*The causes of pus in the urine* which can be remedied by operation as with unilateral hydronephrosis vesical diverticulum, calculus or foreign body, must be dealt with by the appropriate surgical measures.

Occasionally certain *spa waters* such as Contrexeville or Vittel will have a beneficial effect without any explanation for this result.

**GENERAL MEASURES**—Sometimes the general health is poor and can be improved by attention to hygiene, diet and medicinal measures, with ultimate benefit to the enuresis. Where the latter is associated with signs of thyroid insufficiency, the administration of thyroid extract is indicated with some prospects of success. Psychotherapy is a help in certain cases.

Where there is infantile development of the genitals independently of thyroid disease enuresis may sometimes be remedied by the administration of Gonadotrophic hormone. Twelve injections each of 160 m.u. in the course of a month have effected a cure in one of my cases.

Although it is sound advice to restrict the fluid intake towards the end of the day and in the evening, this precaution *per se* is generally ineffective.

Waking the child at certain times during the night to pass water often meets with success. In some cases the mother will show endless patience and concern in trying to ascertain the most effective times for doing this only to find that all efforts are in vain.

Threats and scoldings are generally of no avail and are apt to be definitely harmful for as the child becomes older and appreciative of the abnormal nature of the affliction these may cause a highly nervous condition, a state of affairs which it is important to avoid.

The large range of drugs recommended and used for this complaint is on the whole an indication of their ineffectiveness, when no exciting cause can be found these in turn may be tried. It sometimes happens that one drug or other will be helpful.

Belladonna has deservedly some reputation and is conveniently used in the form of the tincture and to be effective must be given for several weeks under medical supervision. It is useless simply to try a small dose over a prolonged period and it is certainly dangerous to give large doses without frequent observations of the effects. There are the occasional cases who are intolerant of small doses. The parents must be instructed in the signs indicating intolerance to the drug. Still (1927) advises that 5 min. of the tincture may be regarded as a safe initial dose at any age past infancy, and that the dose may be increased by  $2\frac{1}{2}$  min. every fifth or sixth day until either the enuresis is stopped or the limit of tolerance is reached. If the enuresis is controlled by a certain dose this may be increased by a further  $2\frac{1}{2}$  min. if it is tolerated. This dose should be maintained for two weeks and then reduced by decreases of  $2\frac{1}{2}$  min. once a week and eventually discontinued.

Ephedrine is undoubtedly helpful in certain cases, but the drug is sometimes associated with toxic symptoms. Parkhurst (1930) recommends for a child of 10 to 12 years  $\frac{1}{2}$  gr. at night with limitation of fluids.

For details of treatment by other drugs readers are referred to works on pediatrics.

Threadworms when present must be thoroughly eradicated. Although this measure generally does not benefit the enuresis in the exceptional case it does, but in either case there is the undoubted benefit to the general health.

**OTHER PROCEDURES WHICH HAVE BEEN OF VALUE**—The simple passage of a catheter or the instillation of silver nitrate into the posterior urethra has claimed successes. Electrical stimulation of the bladder muscles by means of an alternating current has been advocated and can be carried out in the following way: the negative pole as a small metal knob mounted on a stem is introduced per urethram as far as the membranous urethra. The positive pole is a metal plaque covered with chamois leather placed over the suprapubic region. The current is used in sufficient strength to make the abdominal muscles contract and is switched off about twice a minute. The treatment goes on for five minutes and is repeated every other day. Alternatively a negative pole of carbon covered with chamois leather may be placed in the vagina or the perineum. Benefit has been claimed from the above for some cases, but this procedure would not be practicable with many children.

Injectations of various substances into different regions have had their enthusiastic advocates: the epidural region, the space between the rectum and the sacrum, round the membranous urethra, into the vulvæ and round the urethra in females.

Laminectomy for spina bifida is an operation of such importance that it should come up for consideration only in an old standing and exceptional case and then not until after a fair trial by other methods has failed.

### POLYURIA

Polyuria means an increase in the quantity of urine excreted. Normally the amount passed is between 40 and 60 oz. in the twenty-four hours, and this quantity is excreted more or less evenly over this period. Increase in all cases is a symptom and not a disease. With certain pathological states it is the outstanding and persisting symptom, with others it is merely a passing phase. Urinary disease provides the bulk of the cases in the latter category. In urological work it is most important to recognize the fact that polyuria is a common phenomenon resulting from even minor inflammatory changes of

the lower urinary tract This applies to the posterior urethra as well as to the bladder

Whether the activated renal excretion is entirely reflex or whether it is due to renal congestion from an ascent of infection is not always clear but the latter result does occur and should be kept in mind The fact of polyuria in these cases is often obscured by the increased frequency of micturition which is sometimes a marked feature The most outstanding urinary tract condition which leads to polyuria is prostatic disease with chronic retention

The urine of a patient with polyuria tends to be so pale that it has only the faintest yellow tinge or it may be completely colourless like water Immediately after passing the urine may be clear or turbid but the turbid specimen may clear quickly on standing as a deposit settles in the bottom of the glass or the cloudiness may remain in spite of the formation of the deposit Turbid urine associated with polyuria is commonly the result of renal disease

The specific gravity of the urine of polyuria is consistently low it may reach the level of 1002 only in the polyuria of diabetes with glycosuria is the specific gravity raised above normal in this type of case 1030 is a common figure but it may reach 1060

It is first of all important to keep in mind certain chronic types of polyuria and these should be excluded first when a case is being investigated It is in this category that excretion of urine reaches its highest level—up to 190 oz They are as follows diabetes mellitus diabetes insipidus certain cases of nitrogen retention Bright's disease some derangements of the central nervous system

From other causes we find types which are *transitory protracted* (amenable to treatment) and *chronic* (uninfluenced by treatment) These varieties are met with particularly in cases with urinary tract disease of one kind or another They do not on the whole pass excessive quantities of urine The three varieties offer different prospects as regards prognosis

**Transitory polyuria**—This type can be identified under the following categories

**WITH MILD GASTRO INTESTINAL DISTURBANCE**—Sometimes the polyuria is accompanied by manifestations of this of which flatulence may be a feature this may cause a noticeable protrusion of the anterior abdominal wall These symptoms and signs may lead to a misinterpretation of the sequence of events by suggesting that the polyuria is secondary to the gastro intestinal upset Both of the above states can occur as a result of bladder neck disease or may result from instrumentation

**WITH PHOSPHATURIA** in some cases of this condition

**HYSTERIA**—Caution should be exercised by making a careful investigation before arriving at this diagnosis

**FROM CERTAIN MEDICINAL SUBSTANCES TAKEN BY MOUTH**

**FROM MOST FLUIDS TAKEN IN QUANTITY BY MOUTH**—Sometimes in the form of medicinal substances it may be said in a general way that the absence of such a response would indicate renal insufficiency

**ACCOMPANYING EMOTIONAL DISTURBANCES**—In some people these produce polyuria

**REACTIONARY POLYURIA**—This is seen in certain pathological states and is of great importance and significance from the point of view of prognosis These facts apply particularly in certain urinary tract disturbances such as infections and post operative conditions for example a period of renal failure which is often accompanied by a raised blood urea may be followed by a phase of polyuria Such a reaction invariably indicates an immediately

favourable prognosis the polyuria may last for several days. It is sometimes seen following the relief of prostatic and other types of retention. This change is obviously the result of the relief of a state of congestion of the kidneys.

**REFLEX POLYURIA**—This results from stimuli coming from the bladder or posterior urethra as for example after instrumentation. Repeated bladder contractions also seem able to excite the same result.

**Protracted polyuria**—This term is applied to a polyuria which has been present for a considerable time and then gradually disappears either spontaneously or as a result of treatment.

Protracted polyuria indicates renal congestion and may leave no sign of sclerosis of renal tissue unless the hypersecretion persists unduly.

Certain inflammatory states from which the kidneys recover can produce polyuria which when prolonged calls for a guarded prognosis with regard to impairment of renal function.

**SOME EARLY PROSTATIC CASES** have nocturnal polyuria not only from bladder irritation caused by the enlarged prostate but from renal congestion also. The polyuria may appear suddenly initiating an attack of acute retention and indicating that congestion has occurred in the prostate and the kidneys at about the same time. Prostatic enlargement with **MILD CHRONIC RETENTION** gives rise to frequency which is not only due to the reduced capacity of the bladder but also in some degree to polyuria which may disappear when the obstruction is remedied.

Polyuria from prostatic enlargement with **MARKED CHRONIC RETENTION** is more persistent and may even be permanent—in the latter case requiring a guarded prognosis. The presence of polyuria when decompression by supra pubic tube or indwelling catheter drainage is carried out must be reckoned with in arranging the quantity to be let out of the catheter on each occasion. It may escape recognition until it is noticed that there is little or no reduction in size of the visibly distended bladder in spite of regular withdrawals of urine which are usually adequate in such circumstances. It is not unusual to find that as the decompression progresses the polyuria diminishes. Such a change makes a good prognosis provided that the amount excreted does not fall below normal.

**ACUTE PYELITIS** also gives rise to polyuria. In the circumstances the urine is turbid from the presence of pus. The quantity of urine approaches normal as the inflammatory state subsides.

**ACUTE CYSTITIS** also produces polyuria. This can be attributed sometimes to reflex action on the kidneys from bladder irritation at others to renal congestion which is so often present. Absence of any evidence of renal infection will suggest that the renal hyperactivity is reflex although actual proof is lacking.

**Chronic polyuria**—This is a state which persists in spite of all treatment directed against the cause.

*Diabetes insipidus and mellitus chronic Bright's disease some cases of nitrogen retention and certain derangements of the central nervous system* must be remembered in this category.

In *renal tuberculosis* frequency sometimes produces as much as 70 to 80 oz during the night. Fluctuations in the amount secreted are often noted.

In *prostatic cases with distension* polyuria is of regular occurrence. With some it diminishes as the distension is reduced. With others there is no such response and the persisting polyuria in spite of surgical relief makes a bad

prognosis which may be considered more serious still when there is also evidence of renal infection

### OLIGURIA

A fall in the amount of urine excreted—oliguria—when not due to physiological causes is an important indication of impaired renal function

The diminution may be such that the excretion falls to one quarter of the previous output in the twenty four hours. The oliguria may be entirely orthostatic, i.e. dependent on the upright position. The urine in a case of oliguria is generally highly concentrated. It is dark and soon becomes turbid on standing from the quick precipitation of the salts in solution.

Oliguria may be due to one of the following causes—changes in the kidneys, reflex action on the kidneys, changes in the renal circulation. These influences may act concertedly.

Oliguria may be seen in the following conditions

*From dehydration* when due to insufficient intake of fluid, profuse sweating, diarrhoea, hæmorrhage

*In an attack of fever*

*In certain cardiac states*

*As a phase of acute and subacute renal infection*

*Following operations* especially those on the urinary tract where there has been much loss of blood, e.g. certain cases of prostatectomy

*Advanced renal disease from various causes* the oliguria may occur suddenly

*In acute retention of urine* less urine is found in the bladder than should be following a prolonged retention

*In certain cases of albuminuria* some of these are orthostatic

**Prognosis**—The grave cases are those in which the oliguria supervenes in the presence of pre-existing renal disease. If this is considerable although there may have been an abundance of urinary output before the excretion began to fail the prospects of avoiding a fatal issue are not good.

### ANURIA

Anuria means the failure of the kidneys to excrete urine. When there is no opportunity for the urine to escape from the kidneys anywhere but into the bladder the condition is indicated by the absence of urine from the bladder although sufficient time has elapsed for urine to collect since micturition last occurred. It can result from an extreme degree of oliguria so that anuria may have the same causes. As a rule the prognosis in oliguria—if it tends to persist—is graver than in anuria which may be present with sound kidneys capable of complete restoration of function.

The outstanding feature of a case is the absence of both micturition and the desire to micturate. It is necessary to pass a catheter in order to make a diagnosis.

**The period of tolerance**—This may extend from three to five days and at any rate during the earlier part of this time the patient may suffer no inconvenience. With patients of a hysterical type this period may be even longer as the excretory functions of the kidneys seem with such cases to be taken over to some extent by the excretory activity of the skin, stomach and intestines.

**The period of uræmia**—In the progressive case the period of tolerance slowly gives place to this more serious state which is characterized by vomiting, headaches, œdema, hæmorrhages etc. This phase may extend for another

six days or so when coma gradually supervenes and death is not likely to be delayed beyond a further five or six days

In the exceptional case the anuria resolves itself spontaneously the return of the urinary flow indicating that a condition of well marked polyuria has supervened judging by the extraordinary quantity of urine that is passed

**Mechanism**—Two different processes can be distinguished an arrest of the production of urine an obstruction to the outflow of urine but a combination of both processes generally occurs

**ARREST OF PRODUCTION OF URINE**—This can be brought about by several causes —

- (a) Damage to the excreting elements
- (b) Derangement of the nerve control of the excretory function
- (c) Derangement of the blood flow through the kidney

**OBSTRUCTION TO THE OUTFLOW OF URINE**—Obstruction to outflow along any urinary passage may in due course cause sufficient back pressure on the excreting elements behind the obstruction to arrest their function

**COMBINATION OF BOTH PROCESSES**—This applies to the majority of cases of anuria In certain cases of nephritis for example there is both pre existing damage of the urine producing elements (nephrons) and blockage of the straght tubules Again anuria from a calculus obstructing one ureter is due to the blockage on the stone side and reflex or toxic influence from this on the opposite kidney

**Ætiology**—There are numerous causes of anuria they may be classified as follows —

**OBSTRUCTION TO BOTH URETERS**—Obstructive conditions of the lower urinary tract tumours of the true pelvis pelvic operations resulting in occlusion of ureters from clamp or ligature in bilateral hydronephrosis compression of ureter between distended pelvis and renal vessel

**OBSTRUCTION TO ONE URETER ONLY WITH INHIBITION OF OPPOSITE KIDNEY**—The obstruction may arise from any of the above causes There may be no evidence of disease of the opposite kidney This is not an uncommon state of affairs in anuria

**OBSTRUCTION TO ONE URETER ONLY WITH OPPOSITE KIDNEY DAMAGED OR ABSENT**—A stone in the ureter of the active kidney is perhaps the commonest discovery in this kind of case

**EXTENSIVE DISEASE OF BOTH KIDNEYS OR OF A SOLITARY KIDNEY**—There are certain pathological conditions which if left to take their course tend ultimately to involve both kidneys hydronephrosis polycystic disease lithiasis suppurative conditions and tuberculosis

It is commonly a matter of great interest to observe the advanced state to which renal destruction can proceed before the anuria which leads to a fatal issue supervenes

**ACUTE OR CHRONIC NEPHRITIS**—In these cases there are a cessation of excretion and a blockage of outflow The changes characteristic of nephritis may be produced by poisons e.g. mercury

**SULPHONAMIDES**—It is necessary to give special mention to the anuria which has been reported as a result of therapy with the sulphonamides particularly of sulphapyradine The principal feature of this condition microscopically is that the tubules are packed with crystals These may also be seen protruding from the ureteric orifices

**GENERAL CAUSES**—These include any influence which in due course causes damage to the delicate renal epithelium whose function is so highly specialized



as is the apparatus of renal excretion. They arise from changes in the cardiovascular system certain alterations in the condition of the blood infections toxæmias etc.

**INFLUENCES THROUGH THE NERVOUS SYSTEM**—Evidence that these are effective is suggested from the following examples of anuria (1) When both kidneys are present and there is evidence of only one being diseased (2) After operation on one kidney the other one having been previously proved to be functioning well (3) Sometimes the inhibition may originate in the lower urinary tract as for example after a painful instrumentation.

**HYSTERICAL ANURIA**—This term has been applied where no cause can be found for the suppressed renal activity.

**POST OPERATIVE ANURIA**—In cases where pre operative investigation has shown good renal function on both sides oliguria progressing to anuria sometimes supervenes particularly after operations on a kidney or the bladder. This has been noted particularly after operations for stone and where there has been a considerable loss of blood as in some cases of prostatectomy. Renal congestion an attack of nephritis obstruction of tubules from a high concentration of urinary salts have all to be considered as possible precipitating causes.

**Diagnosis**—Finding no urine in the bladder on catheterization after a considerable period has elapsed since micturition last occurred establishes the diagnosis in most cases. Traumatism with rupture of the bladder may create some difficulty in determining the true state of affairs.

The foregoing conditions mentioned as the causes of anuria would for the most part be identified before the suppression of urine had occurred. A calculus is the commonest cause and the incidents common in lithiasis and a full investigation will have preceded the anuria in many cases. Occasionally however anuria is the first important symptom in which event the diagnosis will not be made until after radiography. In exceptional circumstances a lengthy investigation fails to reveal the cause of the suppression. Anuria from poisoning mercury in particular should be kept in mind in difficult cases while enquiries about sulphonamide therapy especially about dosage should always be made.

A very thorough examination is required before the diagnosis of hysterical anuria is justified.

**Treatment**—This must inevitably depend on the cause and in the presence of uncertainty no time should be lost in making the necessary investigation.

In some cases the outstanding question arises is surgical intervention necessary? If so is it to be ureteric catheterization or open operation?

Where the anuria is due not to a blockage but to a failure of excretion nephrostomy is rarely indicated as any benefit is likely to be very fleeting if it occurs at all.

**EXTRA URETERIC PRESSURE BY A TUMOUR** is not likely to be relieved with any prospect of lasting benefit if the growth is malignant. In the case of a simple tumour the obvious need is to remove the mass. But this type of intervention would not be justified in the first instance if uræmia were present. In these circumstances a choice would have to be made between ureteric catheterization and nephrostomy.

**HYDRONEPHROSIS** with marked kinking of the ureter which prevents the passage of the ureteric catheter into the renal pelvis—as seen most commonly where the ureter is compressed between a blood vessel and the distended renal pelvis—nephrostomy is indicated. The patient may not be well enough to permit of exploration to find and divide the offending blood vessel.

**NERVOUS SYSTEM DERANGEMENT**—Medical treatment is sometimes effective diuretic or alkaline drinks theobromin squills etc may be tried in their turn but some cases in this group do not respond to such treatment Ureteric catheterization is often successful however if not nephrostomy had better be carried out

**BLOCKAGE BY CALCULUS**—(See p 921)

**GENERAL CAUSES**—The cases already referred to under this heading are essentially medical and their treatment falls into this category

**NEPHRITIS**—Although the treatment generally comes within the province of the physician there is occasional justification for nephrostomy in certain acute cases which have failed to respond to conservative measures Nephrostomy and decapsulation are the measures indicated and they must be carried out rapidly on both sides to achieve success Anuria in the more chronic cases including eclampsia does not offer the same prospect of a response from operative treatment

**SULPHONAMIDES**—Copious fluids by mouth or intramuscular injection and alkalis by mouth in some cases restore the renal function Where these means fail ureteric catheterization should be carried out Failure of response from these measures may even require nephrostomy but the most important step to take is to stop the administration of the drug on the first sign of diminishing renal excretion

**POST OPERATIVE ANURIA**—This is a very serious state of affairs A free administration of fluid by one means or another is the most likely method of restoring the renal excretion In this connection if the administration of fluid is carried out intravenously the most careful watch must be kept on the effect of this form of therapy this applies equally to sodium sulphate solution (4.3 per cent) and to normal saline The fluid should be run in by the drip method not quicker than sixty drops a minute If there is no response in renal excretion after the transfusion of 10 oz this method should be discontinued It must be remembered that fluid injected directly into the circulation which does not create a response of renal excretion is accumulating in the tissues and will produce œdema of the kidneys as well as of other organs Such a result must hinder rather than help renal excretion and may quite easily destroy any chances of recovery that the patient may have had If fluid can be taken by the mouth let it be given this way if not it can be given with perfect safety intramuscularly into the outer part of the thighs Several pints if necessary can be given by using both thighs and by controlling the rate of the drip in relation to the rate of absorption

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## CHAPTER XXI

### CONGENITAL MALFORMATIONS OF THE BLADDER

**I**N this section the following congenital anomalies will be considered vesical agenesis hypoplasia or dwarf bladder reduplication trigonal folds diverticula vesical exstrophy subsymphyseal exstrophy and urachal fistula. The notes on the development of the bladder and urethra were contributed by the late Professor D. M. Blair Glasgow University.

#### DEVELOPMENT OF URINARY BLADDER AND URETHRA

**Developmental primordia**—When the tail fold of the embryo has formed there is continued into it a pointed prolongation of the hind gut. Already from the ventral wall of this prolongation a tapering diverticulum the allantois curves forwards into the connecting stalk. The part of the hind gut from which the allantois rises now dilates to form the cloaca and later the pointed end piece of the gut distal to the cloaca shrinks and disappears. The endoderm of the ventral wall of the cloaca and of the ventral wall of the beginning of the allantois that is continuous with it is in the mid line fused with the surface ectoderm to form the cloacal plate a membrane that extends from the caudal end of the primitive streak behind to the ventral wall of the connecting stalk in front. The further part of the allantois is completely embedded in the primary mesoderm of the connecting stalk.

The cranial wall of the cloaca is ridged transversely by the concave lower edge of a wedge of mesoderm that separates the hind gut dorsally from the allantois ventrally. This wedge now grows downwards pushing the endoderm of the cloacal roof before it so as to divide the cloaca into two compartments a dorsal passage continuous with the hind gut which is the rudiment of the rectum and a wider ventral cavity the urogenital sinus into which the allantois opens. The dorsal wall of the urogenital sinus receives the lower ends of the mesodermal mesonephric (Wolffian) ducts from each of which near its end a ureteric bud grows dorso laterally.

*Meantime the cloacal membrane is being surrounded from behind and narrowed by a growth of mesoderm from the caudal end of the primitive streak. This mesoderm advancing along either side of the cloacal membrane passes across the mid line between the ectoderm and endoderm of the cranial part of the cloacal plate and becomes continuous with the mesoderm of the connecting stalk. The shortened hinder part of the cloacal plate then comes to be related to the caudal wall of the cloaca only while the ventral wall of the urogenital sinus and its allantoic continuation are separated from the surface ectoderm by mesoderm in which develop the musculature of the ventral wall of the bladder and dorsal wall of the urethra the symphysis pubis and other structures in the mid line of the infra umbilical body wall. Partial failure of this growth of mesoderm across the cranial end of the cloacal plate is thought by Wyburn (1937) to be the primary aetiological factor in the production of vesical exstrophy and epispadias with subsequent breakdown of*

greater or lesser remnants of the cranial portion of the primitive cloacal membrane

The reduced cloacal plate then becomes divided transversely by the fusion with it from above of the lower edge of the descending urorectal septum between the rectal passage and the urogenital sinus thus completing the separation of these two cavities. The posterior and smaller part of the plate becomes the anal membrane. The anterior and more elongated strip is the urogenital membrane.

**Development of bladder**—The cranial part of the urogenital sinus becomes dilated to form the rudiment of the bladder. The urethra arises from the succeeding narrow portion. The vesical rudiment at first fusiform becomes still more dilated at its lower end and this enlargement opens out the attached ends of the mesonephric ducts beyond the points of origin of the ureteric buds. The orifice of the ureter is thus carried separately in a dorsolateral direction on each side while the opening of the mesonephric duct remains close to its fellow of the opposite side. But the terminal part of each mesonephric duct is now pulled downwards in a redundant loop within the descending urorectal septum in such a fashion that the distal limb of the loop is in contact with the dorsal wall of the lower part of the bladder rudiment and upper part of the succeeding narrower urethral portion of the urogenital sinus. The contiguous epithelial walls fuse and then break down so that the definitive opening of the mesonephric duct is the junction of the lower end of the proximal limb of its loop with the dorsal wall of the urogenital sinus a little way below the vesical rudiment. The narrow part of the urogenital sinus between this point and the vesical rudiment above forms the whole of the female urethra and the upper part of the prostatic urethra in the male.

This opening up and subsequent migration downwards of the lower end of the mesonephric duct has the additional result that part of the future trigone of the bladder and of the posterior wall of the urethra beyond that is of mesodermal origin.

The dilated upper part of the urogenital sinus gives rise to the epithelial lining of the bladder. The muscular and fascial layers of its wall are differentiated from the surrounding mesoderm which dorsally belongs to the urorectal septum and ventrally to the primitive streak outgrowth already mentioned.

The allantois continuous with the cranial end of the vesical rudiment remains of small size and becomes a narrow duct embedded in the first few inches of the umbilical cord. With the lengthening of the infra umbilical part of the body wall the pointed upper extremity of the urogenital sinus is drawn out as a narrow tube attached below to the apex of the bladder proper and above to the umbilicus. Its lumen becomes obliterated except perhaps at the lower end where a minute passage may persist. The fibrous cord that results forms the urachus whose upper part is pulled out into an attenuated thread by post natal growth of the body wall and descent of the bladder.

At birth and for a few years afterwards the apex of the empty bladder still passes above the upper border of the symphysis pubis. But with the relatively greater enlargement of the pelvic cavity that precedes puberty the bladder descends yet further to become when empty an entirely pelvic organ.

**Development of urethra**—The development of the urethra differs in the two sexes. In the female the narrow intermediate part of the urogenital sinus between the bladder and the definitive entrance of the mesonephric ducts

gives rise to the whole of the urethra a few epithelial outgrowths from this passage form the para urethral tubules (of Skene) the homologue of the male prostate The urogenital sinus below this level opens out to form the vulval vestibule, bilateral outgrowths from the upper end of this segment form the vestibular glands (of Bartholin)

In the male this lower part of the urogenital sinus persists as a further portion of the urethra The intermediate part that receives the mesonephric ducts here becoming the ejaculatory ducts forms the prostatic and membranous parts of the urethra The prostate develops from a number of tubular outgrowths on each side above and below the entrance of the ejaculatory ducts The prostatic utricle arises from the lower ends of the fused paramesonephric (Mullerian) ducts that have come to end in the urogenital sinus between the mesonephric duct openings Bilateral outgrowths below the prostatic tubules form the bulbo urethral glands (of Cowper)

The cavernous part of the urethra arises from the lower part of the urogenital sinus this after the disappearance of the urogenital membrane has the form of a narrow groove bounded by bilateral urethral folds The groove extends forwards on to the undersurface of the primitive penis that has arisen by the elongation of a rounded swelling in front of the urogenital membrane the terminal part of the penis becomes demarcated by a slight constriction and forms the glans penis in which the urethral groove ends as a solid rod of cells embedded in its ventral surface The urethral folds fuse together from behind forwards so as to continue the urethral canal which is completed by a groove in the rod of cells already mentioned that quickly closes over almost to the apex of the glans Incomplete fusion of the urethral folds or failure of the groove on the glans to close results in hypospadias

A cylindrical ingrowth of ectodermal cells on the summit of the glans surrounds the orifice of the urethra and by a breaking down of the central cells of this ingrowth a deepening groove comes to separate the prepuce from the glans This groove is always incomplete ventrally where the frenulum therefore remains, any partial failure elsewhere of the ectodermal breakdown leaves an abnormal adhesion of the prepuce to the surface of the glans

### VESICAL AGENESIS

Only a few instances of complete absence of the bladder have ever been reported The condition is usually accompanied by other congenital anomalies incompatible with life The ureters terminate in an unusual position such as the vagina or urethra In the rare event of the bladder being the only organ affected the ureters could be transplanted into the pelvic colon

### HYPOPLASIA OR DWARF BLADDER

This anomaly in which the bladder is represented by a small pocket about the size of a bean is also a great rarity and is accompanied by other deformities A few cases have been observed and reported but like vesical agenesis its interest is largely academic

### REDUPLICATION

True double bladder is uncommon though its incidence has been confused by failing to differentiate such deformities as diverticulum or patent urachus from an actual reduplication Meredith Campbell (1937) describes a complete

and incomplete variety. In the former, two separate bladders are present and there may be two penises and urethrae. Reduplication of the rectum, Fallopian tubes, uterus and vagina has been found associated with this type. In the incomplete variety the bladder may be divided into an upper or cephalic compartment and a lower or caudal compartment by a partial transverse septum or into a right and left compartment by a sagittal septum. The chief clinical interest of an incomplete reduplication is the possibility of mistaking the malformation for a diverticulum. The latter is usually associated with an obstruction to the bladder outlet and its musculature is incomplete.

### TRIGONAL FOLDS

A valve like obstruction to the vesical outlet may be formed by a fold of redundant mucosa traversing the trigone about midway between the interuretrem bar and the outlet. The aetiology of this unusual anomaly is not known. Symptoms and changes in the upper urinary tract similar to those arising from any obstruction at the vesical outlet may occur. The diagnosis is made by cystoscopy and treatment consists in excising the fold.

### CONGENITAL DIVERTICULA

Diverticula occurring in the absence of infravesical obstruction and of true congenital origin are not common. Close (1933) gives the following aetiological classifications of the congenital varieties: (a) Retention in fœtus due to temporary occlusion of the urethral mucosa. (b) A superabundance of embryonic tissue in the bladder wall. (c) The formation of an excess of epithelial tissue at the fusing edges of the Wolffian and allantoic elements of the bladder and a temporary failure of epithelialization between the two. (d) Supernumerary ureteric buds. (e) Patent urachus, the probable origin of all cases found at the vertex.

Congenital diverticula are found near the posterior angles of the trigone where longitudinal muscle fibres are absent or in the vertex. The walls always contain muscle fibres. Although, as stated, true congenital diverticula are not common, the incidence of diverticula in children is by no means rare. This is due to infravesical obstruction occurring in the form of contracted bladder neck and valves of the posterior urethra, conditions which are themselves of congenital origin (see Chap. XXII on Vesical Diverticulum).

### EXSTROPHY OF THE BLADDER (ECTOPIA VESICÆ)

In this condition there is an absence of the lower abdominal and anterior vesical walls. In consequence the posterior wall of the bladder is everted, its mucous membrane exposed and urine is freely discharged externally from the ureteric orifices (Fig. 138).

Exstrophy may be complete or incomplete. In the complete variety, which is the more common, the entire posterior wall of the bladder protrudes. The mass is irregular, fiery red, bleeds easily, and is tender to touch. The lower part of the mass, which corresponds to the trigone and is partly hidden, is smooth. The mucocutaneous margins are well defined and scarred. The sharp walls of the hernial ring can be felt on reducing the extruded bladder. The umbilicus is usually located somewhat lower than normal and may even be obliterated by scarring at the upper margin.

There is a separation of the pubic bones sometimes for several inches, and genital anomalies are always present. The penis is represented by a rudimentary stump, split or grooved above with a wide open epispadiac urethra. The urethral sphincters are incomplete and on the floor of the posterior urethra the verumontanum and the lateral walls of the prostatic urethra may be recognized. The scrotum is smaller than normal often cleft.

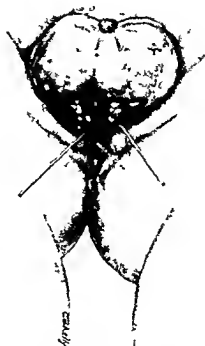


FIG 138

Exstrophy of the bladder in a female child aged 5 years. Catheters have been inserted in the mouths of the ureters which had been transplanted to the pelvic colon nine months previously. (1) shows commencing metaplasia of the mucous membrane. (2) indicates the vaginal orifice. (Mr Matthew White's case.)

and generally cryptorchidism exists. In the female the clitoris is cleft and the labia minora are separated anteriorly, exposing the vagina. Other anomalies such as spina bifida, cleft palate or hare lip as well as malformations of the upper urinary tract frequently accompany the exstrophy.

In the less common incomplete variety the defect in the abdominal wall is relatively slight and the protrusion of the bladder is meagre. The pubes are united and the genitalia normal.

**Symptoms**—Exstrophy of the bladder is one of the most distressing congenital afflictions. As the deformity is computed to arise once in every 40 000 to 50 000 births there must be approximately a dozen fresh occurrences in

Great Britain each year. The sex ratio is about eight males to one female. The victims live a miserable existence, their clothing being constantly saturated with urine. The exposed bladder is painfully irritated by friction and the surrounding skin excoriated.

As might be expected from the exposed position of the ureteric orifices the incidence of ascending renal infection is high. It is said that half the sufferers are dead from this cause by the tenth year. With careful attention however patients may reach adult life and Grey Turner (1929) records the history of a man of 41 years who had been working regularly about the mines from the age of 15 years. At 21 he had submitted to nine plastic operations, the only result of which was to cover the upper part of the bladder by a skin flap.

**Treatment**—Many operations have been devised for vesical exstrophy. Plastic procedures having as their object the closure of the defect in the bladder and abdominal walls were at one time employed. Multiple operations taxing the ingenuity and perseverance of the surgeon and the fortitude of the patient generally resulted in nothing more than a partial covering of the defect. Even if a complete closure were obtained the urinary incontinence remained. The futility of these plastic operations and the excellent results which can follow a successful deviation of the urine by transplanting the ureters into the pelvic colon have made this latter procedure the now almost universally accepted method of dealing with ectopia of the bladder. It is advisable to carry out the operation before dilatation of the ureters becomes established and the kidneys permanently impaired as a result of ascending infection. Grey Turner (1929) is of the opinion that the age of election for operation is between 5 and 7 years for under that age the pelvis is small and the parts are difficult of access.

The repair of the local deformity may be a very difficult problem. It is not essential to carry out this step but its accomplishment will add to the comfort of the patient. A complete metaplasia of the mucous membrane into skin has been observed after the urine has been deviated, the change occurring over a period of several years. The mucous membrane only may be excised or the whole thickness of the bladder wall can be removed. The dissection of the bladder mucous membrane from its bed gives rise to very marked hemorrhage which has to be controlled by suture. After removal of the mucous membrane an attempt may be made to draw together the two edges of the wound but if this is not possible packing is inserted and the unclosed wound is allowed to granulate. To remove the whole thickness of the bladder an encircling incision is made and it is excised in one piece. A deep hole leading into the pelvic cellular tissues results. This is covered over as much as possible by drawing together the widely separated recti muscles. It is particularly difficult to carry out this step in the region of the pubis and it may thus not be possible to obliterate the cavity. In that event it must be allowed to granulate.

In the incomplete variety of exstrophy it may be possible to close the anterior aspect of the bladder and give the patient a more or less normal appearance without undue difficulty.

In the period of the infant's life before operation the exposed bladder should be protected from irritation by keeping it constantly covered with cloths well smeared with vaseline.

### SUBSYPHYSAL VESICAL EXSTROPHY

This condition can be considered as a first degree vesical exstrophy and has a similar embryological aetiology. The deformity is characterized by a



large funnel-shaped patulous bladder outlet readily admitting one or even two fingers. The neck of the bladder anteriorly and the ventral wall of the urethra are absent. There is a separation of the pubic bones, a wide separation of the labia and a bifid clitoris with atrophy of these structures (Fig. 139).

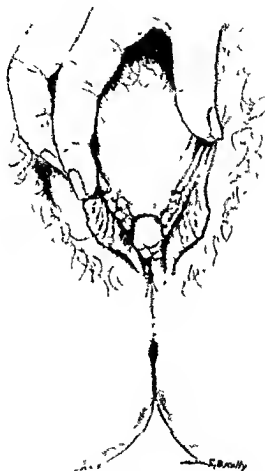


FIG. 139

Sub-symphyseal vesical exstrophy in a woman 31 years of age. Note the patulous bladder neck and the transverse slit like appearance of the external meatus. (A plastic procedure was reported to have been attempted during infancy.)

Lesser grades of the deformity show proportional minor changes, and it is thus customary to recognize three degrees of this female epispadiac anomaly, namely, clitoric, subsymphyseal and complete.

Owing to the accompanying defects in the sphincter muscles, incontinence, either partial or complete, results. The bladder may be capable of holding urine in the recumbent position and in consequence, during infancy and

childhood the lack of control over micturition is sometimes mistakenly attributed to a nervous cause

**Treatment**—There are three different operative methods that can be employed to control the incontinence

A reefing procedure has been successfully used by Hugh Young (1926) The bladder and roof of the urethra are laid open after dividing the symphysis The muscle at the vesical neck is then trimmed away and snugly sutured over a thin probe The bladder is closed up to a cystostomy drainage tube and the pubis united by silver wire Several writers have reported successes by this method the reefing of the urethra being obtained in some instances without symphysiotomy

The second method aims at controlling the incontinence by transplanting an adjacent muscle round the urethra Deeming (1928) used the gracilis



FIG 140

Intravenous pyelogram (15 minute film) taken two and a half years after transplanting the ureters of the patient illustrated in Fig 139

muscle drawing it through a subcutaneous channel into the vagina The muscle was carried beneath the urethra wrapped around it and sutured back on itself Miller (1932) chose the rectus fascia and pyramidalis muscles and brought down strips anterior to the symphysis These were encircled around the urethra and united below it

Transplantation of the ureters into the bowel is the third operative method (Fig 140) It is indicated when control of the incontinence cannot be obtained by plastic procedures

#### URACHAL FISTULÆ

**Ætiology**—Urinary fistulæ at the umbilicus are sometimes described as arising from non obliteration of the urachus R C Begg (1927) in an exhaustive review of the subject has shown this idea to be false in the majority of cases of congenital type and to be without foundation in all examples of acquired urinary fistula at the umbilicus The urachus owes nothing of its origin to the allantois, but, like the bladder is derived from the ventral cloaca, in

point of fact, the urachus is merely the modified superior extremity of the bladder which, in foetal life, reaches to the umbilicus. As development proceeds this superior extremity becomes narrowed and tubular, ultimately forming the urachus. Immediately following birth the bladder begins to descend towards the pelvis carrying with it the urachus. The latter drags the obliterated ends of the umbilical arteries with it and pulls the fibrous tissues of the umbilical scar into a long strand of cord like tissue. In the adult the urachus is rarely more than 5 cm. in length and its upper extremity is actually 11 or 12 cm. below the umbilicus to which it is connected by a single cord of fibrous tissue or by a series of strands which unite at their upper ends. The lowest centimetre of the urachus runs an intramural course in the bladder wall just below the apex, while the rest of the tube lies between the transversalis fascia and the peritoneum. A central canal is present throughout the length of the urachus and generally communicates with the cavity of the bladder although frequently it terminates blindly just external to the vesical mucosa. This central canal has a diameter of only 1 mm. and is further encroached upon by proliferated and shed epithelial cells and debris.

**Types of anomalies**—Begg considers that the commonest type of congenital fistula at the umbilicus occurs when the upper part of the ventral cloaca fails to narrow to form the urachus. At birth the true bladder reaches the umbilicus, there is no urachus and a copious flow of urine is apparent as soon as the cord separates, the condition is really a vesico umbilical fistula and not a uracho umbilical one. A cure is easily effected by closing the opening and in some cases by also removing an existing obstruction such as a phimosis or a congenital vesical neck obstruction. The fistula may reopen in later life from back pressure caused by an enlarged prostate or a urethral stricture.

A second but less common type of congenital fistula may occur when there has been retarded closure of the ventral cloaca to form the urachus. Here the bladder has descended from the umbilicus but the imperfectly formed urachus is still attached to it. Through the small central canal of the urachus urine escapes drop by drop or intermittently. On account of the lack of free egress the canal becomes dilated and septic infection with deep inflammation is apt to supervene.

Acquired urinary fistulae at the umbilicus are of two types, neither of which is due to a permeable urachus in the true sense. In the first type as a result of maldevelopment no urachus has been formed, and the bladder apex is at the umbilicus. In the second and commoner type the bladder has descended and urine escapes from the dilated terminal centimetre of the urachal canal or through the weak point at the junction of the urachus with the bladder. The urine creeps up in the confined space bounded by transversalis fascia in front, the peritoneum behind and the obliterated hypogastric arteries on either side. The effusion is thus conducted to the umbilicus and bursts through the weak point in its lowermost quadrant. Retention and dilatation within the compartment will give rise to cyst formation. A true urachal cyst is, however, formed by degeneration of epithelial cells in the urachus.

An acquired urinary fistula at the umbilicus is thus never due to a patent or persistent urachus.

**Diagnosis**—The diagnosis is evident when urinary discharge occurs from the umbilical area. It is important as Begg emphasizes to ascertain the following points: (1) "Does the apex of the bladder itself reach to the umbilicus and, if so, is the upper segment narrowed in the form of a canal, representing

a partially formed urachus ? (2) Does the urine escape from a normally placed bladder reaching the umbilicus by a fistulous track between the peritoneum and transversalis fascia ?

These questions will be answered by a cystoscopy and X ray studies after injection of radio opaque fluid into the fistula and bladder. Every case must also be investigated for a possible source of obstruction. In children phimosis or congenital vesical neck obstruction may be present whilst in adults stricture and prostatic hypertrophy are the most likely sources of obstruction.

The so called *urachal cyst* is manifested by a suprapubic swelling. As the swelling is behind the abdominal musculature enlargement tends to be chiefly intra abdominal and may produce symptoms of intestinal pressure. The differential diagnosis may be difficult particularly if infection has occurred. Conditions that may be simulated are distended bladder ovarian cyst tuberculous peritonitis and abscess of the appendix.

**Treatment**—Although in cases of congenital fistula early operation is advisable because of the danger of infection it is generally considered that operation should not be performed until the child is a year old. If an obstruction is present and removed the fistula may heal spontaneously or it may be closed by suture. If this procedure fails the bladder should be dissected from the umbilicus its upper narrow part removed and the bladder sutured or alternatively drained and then allowed to close. When a fistulous tract is present between a normally placed bladder and the umbilicus it should be dissected out and the bladder apex freed and repaired. Care must be taken to protect the peritoneal cavity from infection. This operation is not without danger.

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## CHAPTER XXII

### DIVERTICULUM—CYSTOCELE—PROLAPSE

#### DIVERTICULUM

**DEFINITION**—A diverticulum is a pouch like protrusion of the bladder wall forming a cavity which communicates with the lumen of the viscus. It is to be distinguished from cellulæ or false diverticula which are merely shallow depressions of the epithelial lining of the bladder protruding outwards between hypertrophied muscle fibres.

**Structure**—The wall of a true diverticulum is composed of a mucosal lining continuous with that of the bladder and of fibrous tissue the thickness of which varies according to the degree of infection within the sac. Muscle fibres are nearly always present. They are not found in definite layers as in the bladder wall but in bands interwoven with connective tissue. Muscle fibres may also be arranged round the opening of the diverticulum in such a manner as to simulate a sphincter and the opening can then be seen on cystoscopy to dilate and contract.

The majority of large diverticula are single but as many as a dozen may be encountered in the one patient. The size varies from that of a hazel nut to a sac larger than the bladder itself. In some instances the sac is multilocular. The largest diverticulum I have removed had a capacity of one and a half times that of the bladder and occurred in a boy aged 10 years with a vesical neck contracture. The opening into a diverticulum may be large enough to admit the index finger or just sufficiently wide to allow a uretero catheter to be inserted through it.

The most common location of diverticula is just above the ureteric orifices. Occasionally they are found on the lateral and posterior walls and rarely on the fundus and in the urachal area.

**Ætiology**—There is a difference of opinion regarding the mode of origin of vesical diverticula. Some investigators consider that all are congenital in origin and result from a defective development of muscle fibres. That the condition occurs in children and has been found in the fœtus lends weight to this theory. Others believe that all are acquired and are the result of increased intravesical pressure from obstruction at the bladder neck or urethra thus causing herniation at weak points in the bladder musculature. In support of this theory it is pointed out that diverticula are rarely found in the absence of obstruction even in children. It seems likely that there is a congenital predisposition to diverticula formation and that when back pressure from concomitant obstruction makes itself felt diverticula develop at congenitally weak points. The most common obstructive lesions predisposing to diverticula are prostatic hypertrophy, urethral stricture and fibrosis of the vesical outlet. In infancy a pin point urinary meatus and congenital valves of the posterior urethra may exert a similar influence though congenital valves more commonly cause dilatation in the upper urinary tract.

**Complications**—The complications most frequently encountered are infection, calculi and tumours. Infection of a diverticulum is usually associated

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**Complications**—The complications most frequently encountered are infection, calculi and tumours. Infection of a diverticulum is usually associated

with a cystitis. As the sac is often incapable of emptying itself owing to its few muscle fibres and its narrow outlet the consequent stasis is conducive to extension of the infection from the bladder. If the orifice is very small and stagnation within the diverticulum marked the content may become grossly purulent. The thin walls become involved in the inflammatory process and the infection is liable to spread to adjacent structures with consequent adhesions to the rectum or wall of the pelvis. Perivesical suppuration may supervene, and cases have been recorded of rupture having occurred.

Calculi are commonly associated with diverticula owing to the stasis and infection. The calculi may be in the diverticulum in the bladder or in both or a dumb bell stone may lie partly in the bladder and partly in the diverticulum.

The presence of a growth within the diverticulum is said to be rather rare. I have seen four cases, one in a female complicated by a papillary carcinoma.

Part of the growth in each instance could be observed at cystoscopy projecting through the opening into the bladder.

**Symptoms**—There are no symptoms pathognomonic of a bladder diverticulum. The majority of patients are past middle life and the symptoms complained of are those incidental to the urethral or bladder neck obstruction which is coincidentally present or symptoms of cystitis may dominate the picture. Thus frequency of micturition, urgency and vesical tenesmus with pyuria result from the cystitis and difficulty in emptying the bladder or retention from the obstruction. If two successive micturitions are required to empty the bladder and if the first specimen voided is clear and the second purulent a diverticulum is to be suspected.

**Diagnosis**—As there are no classical symptoms to indicate the presence of a



FIG 141

Cystoscopic drawing of the opening of a large sacculus into the bladder (Mr S G MacDonald's case)

diverticulum diagnosis is dependent on objective methods which consist of cystoscopy and X ray. A cystoscopic examination reveals the opening of a diverticulum (Fig 141). It will give no indication of the size of the sac the larger of which frequently have small openings. The depth may sometimes be estimated by inserting a ureteric catheter into the opening. In addition to the cystoscopy giving information about the position and number of the diverticula it will reveal the presence of calculi and tumour and the type of bladder neck obstruction that is present.

The size of the diverticulum is best determined by a cystogram. After making a plain X ray exposure of the bladder the latter is emptied by catheter and then distended with a 5 per cent solution of sodium iodide. An exposure is taken with the patient on his back (Figs 142 143 and 144) and a second whilst lying partly on his side (Fig 145). The opaque medium is now allowed to escape and a further exposure is made after filling the bladder with air. The films thus obtained should reveal the number, position and size of the diverticula (Fig 146). In the contrast film a light shadow is seen corresponding to the bladder and one or more dark areas to the diverticula in which the opaque fluid has been retained. This last film made after the





FIG 142

*Cystogram of diverticulum* This antero posterior view of the bladder filled with 5 per cent sodium iodide, shows a bulge of the right lateral wall. It does not however clearly outline the diverticulum which is directed backwards into the pelvis (see Fig 143)



FIG 144

*Diverticulum of the bladder displayed in a cystogram after micturition* (Professor Illies's case)



FIG 143

*Antero posterior view of a cystogram showing a diverticulum of approximately the same size as the bladder* Note the narrow neck between the two cavities



FIG 145

*Cystogram of the same case illustrated in Fig 143* The exposure was made with the patient lying partly on his side and the diverticulum is completely outlined. It is seen to communicate with the bladder by a wide neck

bladder has been emptied of the opaque medium and filled with air, is of considerable importance as it shows whether stasis is present and may thus indicate whether or not the diverticulum should be removed.

**Treatment**—The mere presence of a diverticulum is not by itself an indication for its removal. Dilatation of a coincident urethral stricture or removal of a vesical neck obstruction whether that be of congenital origin or due to an enlarged prostate will often suffice to relieve symptoms and clear up urinary infection. Diverticula that empty will thus frequently require no special operative intervention after the causative obstruction has been removed. If however one or more infected diverticula are present with a small outlet



FIG 146

Contrast cystogram illustrating two small diverticula. These have retained the radio opaque solution after the bladder has been emptied of it and distended with air.

sac. The bladder is exposed by the extraperitoneal suprapubic route and opened after the peritoneum has been stripped back. The diverticulum is packed with strips of gauze. The extravescical aspect of the bladder is now freed and the semi solid tumour like mass consisting of the diverticulum filled with gauze is identified and dissected free. It is then severed from its attachment to the bladder. The opening thus left is closed in two layers if possible inverting the walls in the process. The bladder is closed up to a suprapubic tube which is delivered from the lower end of the abdominal incision along with a drain from the extravescical space which previously lodged the sac.

When a ureter is involved in a diverticulum (Fig 150) so that a diverticulectomy cannot be performed without dividing the ureter the latter must be re implanted into the bladder.

The intravesical method of diverticulectomy so well described by Hugh Young (1926) is particularly applicable in treating small multiple diverticula especially those that are densely adherent to the adjacent tissues. By means of a suction tube by the application of clamps or by pressure from a finger passed extravescically the sac is delivered into the bladder. A circular incision

and consequent stasis diverticulectomy is usually indicated (Fig 147). Calculi either in the diverticulum (Fig 148) or in the bladder generally indicate operation as does also the presence of tumour (Fig 149). It should be emphasized that removal of the diverticulum and neglect of the accompanying bladder neck obstruction may result in a persistent suprapubic fistula. In a case of mine with a small fibrous prostate which was not dealt with at the time of the diverticulectomy there was a persistent suprapubic urinary leakage until a trans urethral resection was carried out.

It is generally agreed that when operative intervention is called for the procedure which gives the most satisfactory result is a complete excision of the

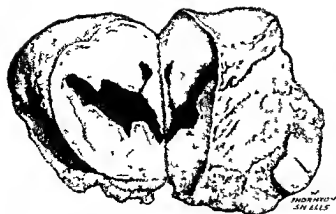


FIG 147

A vesical diverticulum removed from the apex of the bladder of a man aged 37. The sac is walled by a considerable depth of tissue. The orifice of the sac appears as a slit on the lower front of the right hand margin. (Mr Winsbury White's case)

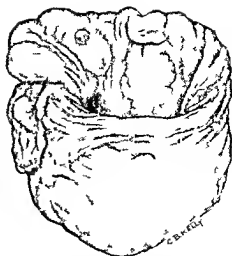


FIG 149

Drawing of a diverticulum and adjacent portion of the bladder wall after resection. The lightly shaded area represents a malignant growth 1 inch as a precaution against cell implantation was diathermied before proceeding with the excision. A second tiny tumour nodule lies near the main growth.

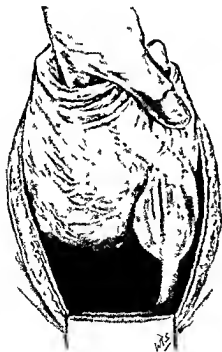


FIG 150

Right ureter opening into vesical diverticulum. The diverticulum was resected and the ureter reimplanted in the bladder. A man aged 39. (Mr Winsbury White's case)

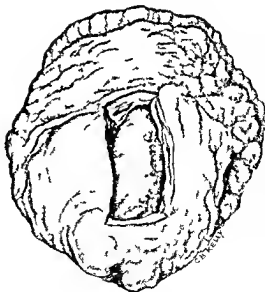


FIG 148

Drawing of a diverticulum after removal. A segment of the wall has been cut away to illustrate the phosphatic calculus which occupied the cavity.

is then made around the opening through the mucosa and submucosa and by blunt dissection the mucous membrane submucosa and if possible a layer of the fibrous wall of the sac are gradually separated freed and excised. Care is taken not to enter the peritoneum which may be found with contained intestines within the everted sac. Vessels which are encountered during the separation are clamped and ligated. The orifice in the bladder is closed with continuous catgut suture tied intravesically. The site of the diverticulum is drained extravesically after mobilizing the lateral wall of the bladder. For adherent diverticula particularly the deep retrotrigonal variety enucleation of the sac can be accomplished without eversion. An incision is made around the orifice through the mucosa which is caught up with forceps. With one index finger inside the diverticulum and the other outside the lining is gradually drawn out by blunt dissection.

When the ureter opens within the diverticulum a special technique is employed to preserve its continuity. As the sac is freed the ureter can usually be recognized joining it from behind. When located a flap of mucous membrane is formed by knife and scissors so as to include the ureteric orifice. When the closure is made care is taken to carry this out in such a way that the ureteric orifice is back within the bladder a Y shaped form of suture being adopted if necessary.

### HERNIA OF THE BLADDER (CYSTOCELE)

A protrusion through a hernial opening of a portion of the bladder is a comparatively rare occurrence. An accidental injury to the bladder in the course of performing a radical operation for hernia is often the first indication of the condition. Wakeley (1930) found 29 instances of hernia of the bladder in 2500 collected cases of inguinal hernia (1.16 per cent) and 11 cases in 196 of femoral hernia (5.6 per cent).

**Ætiology**—Any factor tending to increase bladder volume will predispose to cystocele. In the adult the bladder does not come into contact with the hernial orifices unless it is distended. Accordingly a stricture or an enlarged prostate particularly when associated with a flaccid abdominal wall will favour the formation of a bladder hernia.

Fat in front of the bladder may as a result of traction cause it to pass through one of the hernial orifices and in the presence of very abundant pre-vesical fat the bladder may slip into one of the hernial openings the peritoneum in these circumstances being less adherent.

Some apparent hernie of the paraperitoneal variety are probably the result of traction made on the bladder when isolating the neck of the sac. Traction exerted by an old standing inguinal hernia may also be responsible for this variety.

The frequent operations performed for hernia on children have shown that the condition is by no means a rarity with them. A tight prepuce and a pin-point meatus are the most likely predisposing factors.

**Anatomical varieties**—Hernia of the bladder is almost invariably inguinal or femoral in type though it is possible for a protrusion of the bladder to be associated with perineal obturator or sciatic hernia. Inguinal hernia of the bladder is most frequent in men and is more often associated with the direct than the oblique type. Femoral hernia of the bladder occurs almost exclusively in the female.

There are three varieties of bladder hernia depending on their relationship to the peritoneum.

(a) **PARAPERITONEAL**—This is the most common form and may be direct or indirect (Fig 111 (1)). In Wakeley's series of cases it occurred twenty five times out of a total of forty. The extraperitoneal portion of the bladder is involved and lies on the inner side of the hernial sac. The serous coat of the superior surface of the bladder forms the inner wall of the sac and at operation the adherent bladder covered by a thick layer of fat is easily recognized in this position.

(b) **EXTRAPERITONEAL**—In this variety, which is the least common, there is no peritoneal sac the hernia being solely composed of the anterior or lateral extraperitoneal surface of the bladder (Fig 111 (2)). In consequence the bladder may at operation be mistaken for the sac and inadvertently opened.

(c) **INTRAPERITONEAL**—The intraperitoneal portion of the bladder lies within a complete hernial sac (Fig 111 (3)). The hernia is invariably inguinal in type and enters the canal external to the deep epigastric artery. It is usually large and the sac may contain small and large intestine in addition to the bladder. Wakeley, who records an incidence of fourteen out of his forty cases

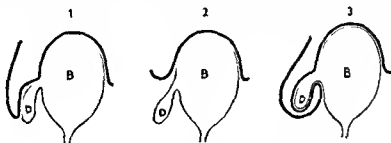


FIG 111

Modified drawing from I. S. H. and H. H. H. illustrating the various types of bladder hernia. The black line represents peritoneum. B, bladder; D, diverticulum; S, sac. 1, Paraperitoneal; 2, Extraperitoneal; 3, Intraperitoneal.

states that the uterus, ovary and Fallopian tube have been found amongst the hernial contents, as have also the prostate and ureters.

**Symptoms and diagnosis**—The majority of bladder herniae are discovered accidentally at herniotomy operations, having previously produced no symptoms pointing to involvement of the bladder. Frequency and dysuria may be complained of, but these symptoms are generally due to a coincident prostatic obstruction or a urethral stricture. It is of significance if the patient tells of an increase in the size of the hernial swelling when the bladder is full and that only after pressure of the hand on the rupture during micturition does the bladder feel properly emptied.

Suspicion of a bladder hernia can be confirmed by cystoscopy and cystography. At cystoscopy it may be possible to observe the opening into the hernial protrusion and a cystogram will reveal a diverticulum like projection passing through one of the hernial orifices.

**Treatment**—In a case of hernia known to involve the bladder, operation would be indicated if the hernia were irreducible or if incarceration occurred. As a general rule, however, the bladder hernia is only discovered at an operation for inguinal or femoral hernia. When the paraperitoneal type is encountered it can generally be separated by gauze dissection from the peritoneal sac and pushed inwards to the abdomen. The sac is then mobilized and ligated high.

up. A purse string suture can be inserted through the floor of the inguinal canal to prevent a recurrence of the bladder protrusion. In the event of it being impossible to separate the bladder from the sac on account of the large area of the bladder wall covered by its eversion around the attachment on the inner side should be carried out. A low ligation of the sac may then be necessary. In the extraperitoneal and intraperitoneal varieties reduction causes no difficulty. The radical cure of the inguinal or femoral hernia is carried out after the bladder has been dealt with.

If the bladder is inadvertently opened during operation and the operator is aware of the accident the opening should be closed by a double layer of catgut sutures and after the operation has been completed drainage of the bladder by an indwelling urethral catheter should be established and maintained for several days. Careful watch should be kept for any sign of perivesical inflammation the advent of which will call for a suprapubic extraperitoneal exposure in order to establish drainage of the perivesical tissues.

The bladder may be injured at operation and the accident not recognized. The prognosis in this circumstance is much more serious and a fatal termination may result particularly if the consequent extravasation of urine is intraperitoneal. It is then necessary to open the abdomen close the rent in the bladder and establish suprapubic drainage. The latter procedure, combined with drainage of the extravasated urine through an incision in the groin or inguinal region will suffice when dealing with an extraperitoneal injury.

### PROLAPSE OF THE BLADDER (URETHRAL CYSTOCELE)

This is a rare condition occurring only in females and is characterized by a variable degree of eversion of the bladder through the urethral meatus. The prolapse may be complete and the entire bladder inverted through the urethra or as is more frequent it may be incomplete and an area of mucous membrane only is prolapsed through the urethra.

The aetiology is obscure but the condition is associated with straining to urinate or defecate. Dysentery prolonged labour and violent coughing or sneezing are possible direct causes. A history of urinary incontinence prior to the appearance of the prolapse would suggest a congenital relaxation of the vesical outlet and urethra as a predisposing cause. Prolonged crying and whooping cough are likely exciting causes in female children.

The prolapsed mass appears between the labia and above the introitus as a red soft vascular swelling which increases in size with straining and can be compressed and generally reduced. It may be possible to recognize the uterine urinary efflux.

A prolapse of the bladder has to be differentiated from a urethral prolapse from the protrusion of a ureterocele from a vesical or urethral tumour or polyp projecting through the meatus and from a urethral caruncle. A urethral prolapse is smaller in size easier to reduce and has a central opening. A ureterocele can also be easily replaced and thereafter can be readily recognized on cystoscopic examination. There should be no difficulty in differentiating a prolapse from a caruncle polyp or tumour.

**Treatment**—It may be sufficient to reduce the prolapsed bladder and hold it in place by a perineal bandage. If the reduction is not successfully maintained it is necessary to suture the bladder to the fascia of the anterior wall. This will necessitate a suprapubic exposure and mobilization of the anterior

bladder wall down to the urethra. The bladder is then pulled well up and sutured to the anterior abdominal wall and subpubic fascia. If a previous urinary incontinence has existed a reconstruction of the bladder outlet may be required.

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## CHAPTER XXIII

### INJURIES OF THE BLADDER

#### INTRAPERITONEAL RUPTURE

**ÆTIOLOGY**—(i) **TRAUMA**—Injuries known to be responsible are those which raise intra abdominal pressure such as blows, crushes and possibly, blast effect. Excessive muscular exertion, as in forced respiratory efforts lifting heavy weights and child birth may be added.

(ii) **OVER-DISTENSION**—This, probably, is not causative in the absence of other agencies. Although Bartels (1878) found 35 per cent of these ruptures took place during alcoholic intoxication, and Lipow and Vogel (1942) also called attention to the incidence, trauma in such cases would be difficult to exclude. Bladders paralysed from cord disease or injury are known to rupture, but here trophic or other factors may alter natural resilience.

(iii) **PATHOLOGICAL PREDISPOSITIONS**—Cystitis, especially tuberculous, ulcers and neoplasms provide examples. I have had two personal cases of "spontaneous" rupture of sacculated bladders chronically obstructed by the middle lobe of the prostate. Suture and suprapubic drainage was performed as a first aid measure in either case, and both, later, were found suitable for endoscopic resection. The retroverted gravid uterus was responsible in early pregnancy in cases reported by Martin (1909) and Chisholm and Ferguson (1939). I have seen one case of spontaneous rupture during the period of rigors in a male subject undergoing malarial therapy for G.P.I. Here autopsy showed no cause other than cystitis. Dixon and Strohl (1936) reported a similar case from the Mayo Clinic.

**Pathology**—Usually all the coats, occasionally the mucous only, give way. Ruptures, tending to follow the lines of cleavage and corresponding to the direction of fibres of the longitudinal muscle coat, are found as antero posterior splits sometimes Y-shaped sometimes duplicated in the unsupported postero-superior wall (Fig 152). They occasionally extend beyond the peritoneal reflections. The degree of resultant peritonitis is governed by the amount, time interval and infectivity of urinary extravasation.

**Symptoms**—Hypogastric pain is immediate and often severe enough to cause syncope. Shock, while usually considerable and merging into the prostration of peritonitis, may be slight. The patient in this case, after a short interval, being able to pursue his occupation. Retention of urine is typically complete, exceptionally urine may be passed copiously when the gap is stopped by adherent omentum or a mucosal flap.

**Diagnosis**—The proof is usually given by urine retention, easy catheterization and an empty bladder. Evidence of free intraperitoneal fluid is significant.

**DEDUCTIONS FROM CATHETERIZATION**—Whilst usually revealing an empty bladder the reverse is not unknown, explained by a partially sealed or an unusually high opening. The catheter may draw off a quantity of urine by tapping a peritoneal collection directly. Repeated withdrawal of the same quantity suggests the former, and a further escape of urine on changing the



posture of the patient may explain the latter anomaly. Attempts to recover measured quantities of fluid introduced through the catheter are injudicious.

**CISTOSCOPY**—What information is gained is of little value and is outweighed by the risk of further extravasation entailed by fluid distension.

**RADIOGRAPHY** by defining bone integrity assists in differentiating from extraperitoneal rupture.

**CONTRAST RADIOGRAPHY**—Excretion urography may show a filling defect and extravasation. Instrumental cystography is contraindicated unless

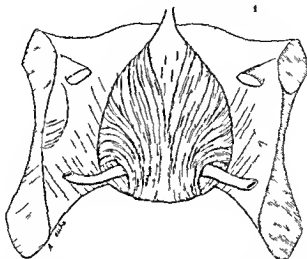


FIG. 139

Intraperitoneal rupture of the bladder. The lines of cleavage tend to follow the arrangement of the fibres of the external longitudinal muscular coat. (1) Shows area of weakness and the site of rupture.

preparation for immediate operation has been made (Grasser and Heuser 1938). Besides those in common use, air has been found a valuable contrast medium.

### EXTRAPERITONEAL RUPTURE

Though occasionally found associated with the last group and the outcome of a similar accident, the majority of extraperitoneal injuries are in fact tears caused either by displaced fractured bone ends or by the drag of fascial or ligamentous structures. Dislocation of the symphysis pubis or fracture of the body, fractures of the rami of the pubes and ischium, or of the floor of the acetabulum or of the body of the ischium establish direct trauma. Abnormal strains upon the supporting ligaments of the bladder, especially the pubovesical, can also be causal (Fig. 153). According to Walev's (1929) report, injury to the lower urinary tract as a result of fracture of the pelvic girdle is not so frequent as is generally supposed. In 44 of the latter there were only 6 examples, 3 of the bladder and 3 of the urethra. In 24 fractures of the os pubis there were 5, 2 of the bladder and 3 of the urethra. Peacock (1939) in 113 cases of fractured pelvis found an incidence of 8.8 per cent ruptured bladders. Bartels reported many years ago (*ibid.*) fractured pelvis to be present in 38 per cent.

**Pathology**—The rupture is usually situated in the anterior wall, less commonly low in the lateral walls or posteriorly. Escaping urine follows the

line of least resistance the same field is invaded as with rupture of the deep urethra i.e. the pelvic areolar tissue the cave of Retzius, up over the pelvic brim and through the sciatic notch and obturator foramen (see (Fig 209)

**Symptoms, signs and diagnosis**—At first the manifestations are obscured by the effects of a major skeletal or visceral injury later they may be difficult to distinguish from intraperitoneal rupture of the bladder or rupture of the posterior urethra Urine retention in the presence of the empty bladder simulates the former, a distended bladder determines the latter Caution in the use of the catheter as an aid to diagnosis is emphasized (p 394), further, a catheter may mislead by tapping an extravascular collection of urine, as in a personal case where 8 oz. were withdrawn from the cave of Retzius, the catheter traversing a tear in the anterior wall of the bladder This observation

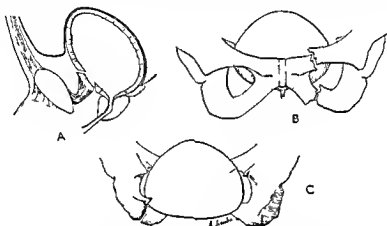


FIG 153

Skeletal factors causing extraperitoneal rupture of the bladder  
A Traction of pubo-vesical ligament B Fracture of ramus  
C Fracture of the ischium

demonstrates how such an extravasation can cause a hypogastric swelling liable to be mistaken for a distended bladder Evidence of extravasation elsewhere aids diagnosis

### TREATMENT OF RUPTURED BLADDER

Formerly drainage by the indwelling catheter was the established method and cures were claimed by Morris (1887) and others To day the importance of earliest possible surgical intervention is universally acknowledged The first laparotomy, without bladder suture, was successfully performed by Syme (1848) Willet sutured a rupture (1876) but fatal peritonitis followed

**Technique**—A catheter may be passed to exclude ruptured urethra, it should be left *in situ* during the operation A median or paramedian incision is made from the pubes to the umbilicus with the patient in the moderate Trendelenburg posture If blood and urine immediately escape the rupture is extraperitoneal but as possibly, it is intraperitoneal as well the parietal peritoneum should be inspected Oedema, bulging and discoloration indicate the need for opening the sac, blood stained urine may escape and is aspirated

**Intraperitoneal rupture**—The full Trendelenburg posture is arranged and the intestines are packed aside to expose the bladder, noting meanwhile that

there are no associated visceral injuries. A tear is picked up and its edges trimmed if lacerated. Suturing is carried out in two layers the first consists of interrupted through and through stitches whilst the second includes the outer coats only, burying the first. The peritoneum is closed completely unless peritonitis requires drainage. Cystostomy is established by incising the anterior wall below the peritoneal reflection and inserting a Winsbury White tube the edges of the wound being close sutured around it to procure water tight drainage. The eye of Retzius is drained.

**Extraperitoneal rupture**—The preliminary steps are similar. The prevesical space is cleared of extravasations and the anterior wall of the bladder examined. If a tear is found the interior is examined digitally through it for bone fragments and for further tears. In such a case after removal of bone fragments the operation is completed by closure of the opening round a self retaining tube. If the anterior wall is intact an exploratory incision is made through it with the same object. Lateral and posterior tears are inaccessible and suturing could only be accomplished by wide retraction to allow of direct inspection. Suturing is unnecessary and injudicious in the presence of the state of shock which is generally severe and protracted in these cases. Exception might be made if the tears were thought to invade the peritoneal coat when their closure is imperative. The operation is completed by tube emplacement as above. In either case the prevesical space and more distant fields of extravasation are generously drained.

**Cystostomy** is advocated in each type of rupture to ensure adequate post operative drainage. To rely upon voluntary micturition or the indwelling catheter is to hazard distension with the risk of the septic sequelæ of extravasation, peritonitis, pelvic cellulitis with abscess formation and fistulæ may thus be invited.

The urethral catheter introduced at the operation serves as a useful landmark, it is not retained. Suprapubic drainage is continued for about a fortnight after which the fear of extravasation no longer exists.

## WOUNDS OF THE BLADDER

**I Wounds received from without**—The majority of these are incurred directly by missiles of war or indirectly through the agency of bone displaced by them. Others result from perineal impalement as by falls and stabs and in the process of bull fighting.

**GUNSHOT WOUNDS OF THE BLADDER**—British and American records showed that the bladder was injured in 47 per cent of perforating wounds of the abdomen in the 1914-18 war. Intraperitoneal wounds are likely only if the bladder is distended at the time of receipt of the injury. Extraperitoneal wounds are therefore more frequent in warfare in the proportion of 4 to 1, partly because a broader target is offered unless the bladder is distended but mainly from the liability to its laceration from adjacent bone.

**Pathology**—The majority of entry and exit wounds are found in the buttock, some in the perineum others near the great trochanter. Hypogastric wounds are in the minority. Retention of missiles in the cavity is frequent. Wounds of the fundus are found to be smaller than the missile, reduction in size records with the degree of distension at the time of injury. In consequence they may be difficult to locate at operation and pre-operatively their symptoms and signs may be elusive from their tendency to become valvular. Natural voiding may then be possible or the surgeon carrying out catheter investigation may be misled. An opening of this occult nature over

looked is the more likely to originate the disastrous consequences of extravasation. Long tracks to the bladder allow soft parts to buffer the opening and prevent superficial escape, alternatively, with a large hypogastric or perineal entry or exit wound there is no such resistance so that deep extravasation is unlikely and an uncomplicated course and rapid healing may be seen for urine bathing a superficial wound is no deterrent to the natural process of repair.

**Course and prognosis**—These depend upon (i) associated injuries, *ie*, to the peritoneum and viscera, bone, etc., (ii) the amount and effect of extravasation (iii) hæmorrhage (iv) sepsis. Early surgical intervention offers the only prevention of complications of an injury not serious in itself but mortal in consequence of them.

**Symptoms**—In perforations by bullets or small H E fragments when the bladder is empty pain and general disturbance are at first no greater than with a flesh wound they develop with extravasation. If there is free external escape a mild course follows. Inability to void is the rule, blood-stained urine may be passed accompanied by pain. Early collapse, vomiting and abdominal distension indicate peritoneal irritation, bowel perforation or hæmorrhage. Hiccough and a toxic state without distension suggest extraperitoneal extravasation.

**Physical signs and diagnosis**—The main features correspond to those observed with contusion ruptures. Additionally sepsis complicates the picture, and since anatomical definition is obliterated, as boundaries are broken by the haphazard course of the missile, physical signs are conflicting. Vesico-intestinal fistula is apparent from escape of flatus or feces with urine from a superficial wound, or a discharge of urine per rectum.

**RADIOGRAPHY**—This is required for localization of a missile or assessment of bone injury.

**Treatment**—Immediate operative interference is undertaken unless (i) Resuscitation is insufficient or (ii) there is a superficial wound giving easy escape for urine.

(i) Recovery from shock is essential if a prolonged operation to deal with complications, especially intraperitoneal, is contemplated. Since the essential step for the bladder lesion is extraperitoneal cystostomy, which can be performed under local anaesthesia, there need be little delay should the bladder alone require operative treatment.

(ii) Large hypogastric or perineal wounds discharging urine freely and showing little contusion or laceration, provided there are no signs of deep complications may be treated expectantly.

*The objects of operation* are excision of superficial tracks, removal of bone fragments or missiles from the bladder, toilet and closure of some bladder wounds, preservation of an empty bladder by extraperitoneal cystostomy, extravescical drainage and attention to associated injuries.

**Technique**—The excised track of a hypogastric wound may, if suitable, be extended to give approach to the bladder and peritoneal reflection. If the tracks are too deep or distant, a standard median or paramedian exposure from the symphysis upwards, as far as necessary, is made. When its appearance is suggestive the peritoneum is opened and explored. Intestinal toilet is primarily effected. If a wound in the bladder is found, its edges are trimmed and sutured in two layers. The peritoneal sac is closed without drainage unless peritonitis is threatened by a retained missile, etc. Cystostomy is established through the anterior bladder wall in the manner already described. The case of Retzius is drained.

Should the perforation involve the extraperitoneal part the same principles are observed as were described under ruptures. It is debatable if when digital exploration discloses a posterior wound of the viscus likely to communicate with the rectum suture should be attempted from within the cavity. Gordon Taylor has recorded his inclination to carry this out. The size of the wound would be a deciding factor. Small wounds tend to heal satisfactorily and quickly others after a period during which a fistula exists. A fistula usually requires colostomy preferably in the transverse colon to keep this well away from the cystostomy opening. With wound tracks in the recto vesical region of the pelvis severe suppuration is likely drainage to avert this must be thorough and may require counter openings in the perineum ischio-rectal fossa or coccygeal region. Removal of the coccyx may be advisable to further this object.

A perineal wound discharging urine may indicate a long and deep tract involving in addition to the bladder the rectum and peritoneum. Digital exploration of it whilst a metal bougie is in the bladder will help to decide the extent of injury and if abdominal exploration is necessary.

Where large hypogastric or perineal wounds are discharging urine freely without evidence of local or constitutional complications nothing beyond local excision of the wound or the use of an indwelling catheter may be required to hasten closure. Undoubtedly the value of penicillin has been proved in many of these cases.

**II Wounds received from within in the course of operations, etc.**—The surgeon operating in its vicinity should be well aware of the risk of injuring the bladder. Results should not be serious if the damage is immediately recognized and rectified by suture local drainage and urinary deviation by cystostomy or the use of the indwelling catheter. Deliberate incision or limited excision of the bladder wall may be a necessary part of an operation and when conducted upon proper lines it is commonplace knowledge that an uncomplicated course can be expected. The following groups of operations may be said to jeopardize the bladder —

- (a) Subumbilical laparotomy when the bladder is distended adherent to the abdominal wall as the result of inflammation or of former operations or drawn up by attachment to the pregnant uterus *e.g.* Cæsarian section or adherent to an abdominal viscus or tumour. A vesical diverticulum (urachal) might be opened.
- (b) Radical cure of inguinal or femoral hernia especially when strangulated.
- (c) Operations performed deep in the pelvis from an abdominal approach. These may be either intraperitoneal or extraperitoneal and are probably for the removal of uterine ovarian or rectal tumours or for exploration of the terminal inches of the ureter.
- (d) Vaginal operations hysterectomy ovariectomy and repairs. Mal application of obstetric forceps and attempts at criminal abortion may be included in this group.
- (e) Trans urethral operations upon the bladder and prostate catheterization cystoscopy litholapaxy diathermy application to bladder growths and electro resection and punch operations upon the prostate. Two factors are causative over distension and trauma from the instrument itself in the latter case perforation may be delayed until a slough separates. In this group pathological factors may predispose to rupture.
- (f) Symphysiotomy and pubotomy.

**Diagnosis and course**—The opening being, as a rule, small, extravasation limited and sepsis mild the clinical picture will probably be equivocal. In superficial wounds—as *e.g.* for herniotomy—pain, redness and œdema with pyrexia are usually mistaken for the signs of simple sepsis, unless there has been hæmaturia or until a urinary discharge or odour is observed. Complicating deep pelvic operations there is less disturbance from extraperitoneal than from intraperitoneal extravasation, although in the latter it may at first be insignificant, perhaps shown as rather excessive post operative pain and some pyrexia. Symptoms become exaggerated by the seventh to tenth day, when suddenly an abscess points either through the abdominal incision or vaginally. The discharge of pus will be followed by one of urine, the commencement of a fistula. This will probably eventually heal spontaneously but more rapidly if assisted by an indwelling catheter. Intraperitoneal extravasation will cause some peritonitis which is usually localized. An abscess within or outside the sac may require incisional drainage. A sudden flooding of the peritoneal sac when the bladder yields under too great operative distension will cause severe shock and peritonitis, unless drainage be immediately established. In such cases cystostomy is preferable to an indwelling catheter.

Immediate repair during incisional operations should be carried out if the accident is recognized and when the injury is within surgical reach, local drainage of the area likely to be soiled with urine should be arranged and bladder drainage established by catheter or cystostomy. Suture would not be attempted when the bladder yields under operative distension. In the majority where the course has disclosed the lesion treatment consists of opening up superficial wounds as far as necessary incision of areas infiltrated with urine and of abscesses and bladder drainage. Local œdema may preclude the use of a catheter and necessitate cystostomy. At the same time sepsis is countered by sulphonamide preparations, notably sulphathiazole and sulphadiazine.

**Results of injuries to the bladder**—**EARLY RESULTS**—(1) Primary mortality, especially from penetrating wounds is high, figures are not obtainable as the injury may be instantaneously fatal from shock, hæmorrhage or extensive bowel or other associated injuries. (ii) Delayed mortality, *i.e.* death within a month. This is accounted for by secondary hæmorrhage, peritonitis, pelvic cellulitis and severe infection either urinary or systemic. Septic osteomyelitis may be a contributory cause.

In regard to ruptures by contusion, all are agreed that early operation offers the highest hope of recovery. Thomson-Walker (1914) quotes Dambrin and Papin (1904) to emphasize how, with intraperitoneal rupture, mortality fell from 43.5 to 20.5 per cent. with improved surgical procedure and Zuckerhantl who found a recovery rate in similar cases of 61.3 per cent. if operated upon within the first twelve hours, but of only 28.8 per cent. if after that limit. Hamilton Bailey found a mortality of 11 per cent. if operation were within the first twenty-four hours after that it rose to 55 per cent. On the other hand a long time lapse to operation or the withholding of operation is by no means invariably fatal for Blumer (1900) and Quick (1907) operated with success on the sixth and tenth day respectively. Zuckerhantl (quoted by Thomson-Walker) found spontaneous recovery in 63 per cent. of extraperitoneal ruptures and Mitchell (1898) 17 per cent. even though extravasation had taken place. Culver and Baker (1940) reported recovery in three out of sixteen cases by catheter alone.

Summarizing, it may be said that under suitable circumstances and provided that operation can be performed within the first twelve hours a mortality

rate of no higher than 10 per cent should be expected associated with severe fracture of the pelvis the figure rises to 20 per cent

In penetrating wounds the record is gloomy in the extreme even though early operation be performed Gordon Taylor (1940) succinctly in the following brief summary gives expression to the experience of surgeons in the 1914-1918 war —

#### BLADDER INJURY WITHOUT DAMAGE TO OTHER VISCERA

Intraperitoneal injury 5 cases Mortality 60 per cent  
Extraperitoneal injury 20 cases Mortality 55 per cent

#### BLADDER INJURY ASSOCIATED WITH DAMAGE TO OTHER VISCERA

Bladder plus small intestine	12 cases	} Mortality 93 per cent
Bladder plus small intestine plus colon or rectum	2	
Bladder plus colon and rectum	4	Probably all fatal

He recorded however two personal cases where he was forced to carry out extensive intestinal resection in addition to repairing the bladder both were successful as were a case each of Gordon Bell and D C Taylor Fullerton (1918) found fracture of the pelvic girdle in 40 per cent of bladder injuries Including injuries to the bowel the incidence of the combination was no less than 70 per cent Cathelin (1918) who found the wound of entry to be posterior in 62 per cent of his cases recorded a mortality of 50 per cent in uncomplicated cases and 75 to 80 per cent in complicated

Personal contact with large numbers of war wounds of the genito urinary organs arriving in England from mainly the Mediterranean and European theatres during the last world war has led the writer to believe that a complete compilation of statistics will show a much improved recovery incidence Better organized advanced surgical units improved wound technique blood transfusion facilities and the wide adoption of penicillin and the sulpha compounds mark the introduction of a new era in war surgery

LATE RESULTS—Sepsis fistulae chronic bone disease and other orthopaedic complications are responsible for the protracted convalescence of survivors Sepsis within the urinary tract is extremely obstinate and ultimately tends to promote calculus formation in the upper as well as the lower urinary tract Ascending sepsis may in time cause a chronic pyelonephritis and pyonephrosis ending in renal failure In cellular tissue and bone recurrent abscess formation and excessive fibrosis may cause nerve pressure and aggravate the difficulty of treatment of fistulae These sequelae emphasize the need for energetic antiseptic measures in the early stages locally by bladder washing while the tube is in position and orally by the sulphonamide group Later every effort must be made to prevent alkalinity of the urine acid sodium phosphate ammonium nitrate or ammonium chloride is given by the mouth and the bladder may be washed with weak acetic acid

JOHN EVERIDGE

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## CHAPTER XXV

### NEW GROWTHS OF THE BLADDER

**INCIDENCE**—Primary growths of the bladder are most common from the third to the sixth decade they are rare in childhood. They are more frequently found in males than females in the proportion of 4 to 1.

Secondary growths in the bladder are rare though implantation growths from a primary papilloma of the renal pelvis or ureter are met with not infrequently and involvement of the bladder by extension of growth from neighbouring organs—prostate urethra rectum uterus—is not uncommon. Beyond the fact that villous papilloma is an industrial disease amongst dye workers nothing is known as to the causation of bladder growths.

#### CLASSIFICATION

New growths of the bladder are mainly of epithelial origin and commonly classified as benign and malignant.

*Benign*—Villous papilloma

*Malignant*—Malignant villous papilloma  
Nodular and infiltrating growths  
Squamous celled carcinoma

Other benign epithelial growths such as adenomata and connective tissue growths such as angiomas myomas fibromata and sarcomata are all rare. Dermoid cysts have been described.

Clinically it is most convenient to divide bladder growths into three categories —

- (i) Growths probably benign
- (ii) Growths certainly malignant
- (iii) Growths of doubtful nature

**1 Growths probably benign**—These are single pedunculated papillomata with long villous processes occurring in young subjects e.g. under 40 years of age. This age is purely arbitrary since it is impossible to say that any given papilloma even under this age is benign equally it is impossible to say that any particular papilloma in a patient even considerably over 40 years of age is not benign but it must be regarded with suspicion. Probably 50 per cent of all bladder papillomata are primarily or inherently malignant and the rest unless cured by surgery eventually undergo a secondary malignant change. All primary papillomata whether benign or malignant are found to arise in close relationship to one or other ureteric orifice generally a little behind and to its outer side.

**2 Growths certainly malignant**—These are —

- (i) Bald growths
- (ii) Nodular and infiltrating growths
- (iii) Squamous celled carcinoma (Fig 154)

**BALD GROWTHS** so called from their cystoscopic appearance are sessile growths often covered with a powdering of phosphates. Microscopically they are papillary carcinomata in which the spaces between the papillæ have become obliterated or adjacent papillæ have fused so that a bald solid looking growth results (Fig 155). This is the most common type of bladder carcinoma and like the papilloma arises in close relationship with one or other ureteric orifice.

**THE NODULAR OR INFILTRATING GROWTHS** occupy a larger portion of the bladder wall and may arise in any part of it. They are hard on palpation their surface is irregular and may be but little elevated above the surface or quite large masses may project intravesically. Ulceration and areas of necrosis may be present. Histologically these infiltrating growths are difficult to



FIG 154

Cystoscopic view of carcinoma of bladder showing central ulceration in a man aged 65 (Mr Wansbury Whate case)



FIG 155

Cystoscopic drawing of a carcinoma of bladder (bald polyp)

classify as various types of cell are found from the normal transitional bladder epithelium to the ordinary spheroidal celled carcinoma the latter may be alveolated and highly cellular or of the scirrhous type. Adenocarcinoma is a rare type arising in mucous glands in the region of the trigone and internal meatus (suburethral glands of Albarran).

**3 Growths of doubtful nature**—This category comprises most papillomata occurring after the age of forty. Their bases are broad and sessile rather than pedunculated and the villi short and stunted—the shorter the villi the more likely is the growth to be malignant. Other points favouring malignancy are the presence of ulceration or necrosis and incrustation of the surface with urinary salts the presence of puckering or oedematous bullæ round the growth or the presence of outlying nodules beyond the main growth all these points denoting infiltration of underlying tissues. Multiplicity of growths is of doubtful diagnostic significance if two or three papillomata are present they are probably benign though one of these may have undergone malignant change so that a benign and a malignant growth may be found in the same bladder. In the same way a benign recurrence may follow resection of a malignant papilloma. When a stage of general papillomatosis is reached they are certainly

malignant (Fig 156) Implantation growths secondary to a renal or ureteric papilloma are always malignant The histological diagnosis of these doubtful



FIG 156

Composite cystoscopic view of malignant papillomata on vesical trigone in a man aged 33 Patient lived for 11 years after treatment of growths by implanting radium (Mr Winsbury White's case)

growths appears to be as difficult as their clinical diagnosis since growths reported benign by the pathologist may subsequently and rapidly prove malignant This raises a suspicion that others reported as malignant but which subsequently do not recur may have been benign Infiltration of the base of a papilloma proves its malignancy, but absence of infiltration does not prove its innocence the ultimate test is whether the growth is composed of cells of malignant type Clinically infiltration can be gauged when the bladder is opened by observing whether the mucous membrane slides over the underlying muscle when traction is made on the growth

#### PAPILLOMA OF THE BLADDER

**Pathology**—The villous papilloma may be pedunculated or sessile (Fig 157), on microscopic section the stalk or base is seen to consist of delicate connective tissue containing elastic and plain muscle fibres supporting numerous blood vessels each branch or villus (of similar structure) is covered by several layers of transitional epithelium The villi vary in length A primary villous papilloma is generally seen to originate from a point behind and to the outer side of one ureteric orifice It may remain solitary for a long period gradually increasing in size, but eventually small buds appear the first ones close to the original papilloma, and later ones scattered over the surface of the bladder They are locally infective spreading by contact or by implantation a small portion being detached and implanted on the bladder mucosa Recurrence after excision



FIG 157

Recurrent sarcoma of the bladder in a child aged 2½ years The fungating mass has widely reopened the suprapubic fistula (Mr Winsbury White's case)

is common and implantations are apt to occur at the site of the excision and in the suprapubic scar. Eventually papillomata undergo malignant change and begin to infiltrate the bladder wall. The ureter and kidney on the corresponding side may show some dilatation.

**Ætiology**—Little is known as to cause the fact that bladder papillomata occur specially in dye workers suggests the action of some chemical irritant on the bladder mucous membrane.

**Symptoms**—So called symptomless hæmaturia is the characteristic feature. Bleeding occurs without obvious cause lasts for one or two micturitions or for a day or two and then ceases. After a shorter or longer interval bleeding recurs as time progresses the intervals become shorter and the bleeding more severe and of longer duration. Clots may be passed and produce difficulty in micturition and even clot retention. Difficulty may also occur from the growths being carried down in the urinary stream to the internal meatus. Small portions of growth may be broken off and recognized in the urine. Occasionally the growth is caught in the internal meatus producing strangury or bleeding from the urethra. A slight renal ache in the corresponding loin is not uncommon. With the advent of infection pyuria will be present with frequency of micturition and pain as in cystitis.

**Complications**—These consist of anaemia from repeated hæmorrhages infection either spontaneous or following instrumentation and retention. Retention may be due to the formation of clots in the bladder or result from the growths being carried downwards in the urinary stream during micturition so that it engages the internal meatus.

**Course and prognosis**—Papilloma of the bladder is a precancerous condition. A papilloma may remain single for many years but sooner or later other growths appear in the bladder and eventually end in malignancy. The writer has seen a case of spontaneous cure of a papilloma from sloughing of the pedicle. The growth then lay free in the bladder and was evacuated with a Bigelow's evacuator.

**Diagnosis**—This is made with the cystoscope which discloses an irregular tumour close to one or other ureteric orifice—generally behind and to its outer side—and often obscuring it. Long delicate villi each with a central vessel are seen floating in the medium. The growth may have a long pedicle or may be sessile. Smaller growths may be present in close relationship to the primary one or scattered over the surface of the mucosa.

**Treatment**—The two alternatives are perurethral destruction of the growth by diathermy fulguration or its excision by suprapubic cystostomy. For small growths diathermy is the mode of election. The patient should be given a general anaesthetic and the growth destroyed at one sitting (Figs 159 to 161). The advantage of fulguration apart from avoiding an open operation is that recurrence is less common. The growth is destroyed piecemeal and implantation growths thus avoided. Microscopic papilloma buds not yet visible may be present already at the time of diathermy and these will develop in course of time. Every case should be cystoscoped therefore every six months after diathermy and continued until the patient has had at least three years free from recurrence. Diathermy can be carried out with a small electrode applied through an ordinary catheterizing cystoscope but it saves a lot of time to use a cystoscope which provides for continuous irrigation (see also p. 376).

For growths springing from the internal meatus which cannot be reached with an ordinary cystoscope a special cystoscope is made with a lever which directs the electrode backwards through nearly 180 degrees.

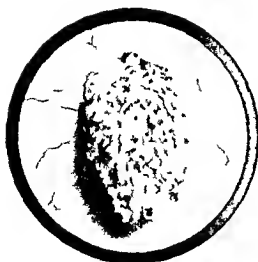


FIG 158

Cystoscopic view of pedunculated papilloma of the bladder showing thrombosis on surface

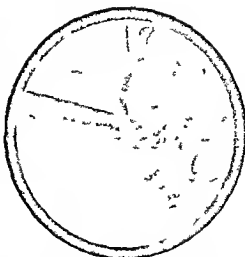


FIG 159

Close up view showing coagulation on bladder wall during athermy in progress

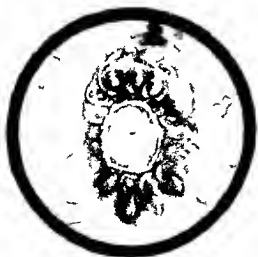


FIG 160

Appearance 3 weeks after coagulation. The site of the separated pedicle is surrounded by bullous edema



FIG 161

Site of growth 3 months after coagulation. The pale area represents scar formation

Larger growths and multiple growths can be dealt with most quickly and efficiently with Kidd's cystoscope (Fig 162). This is made of bakelite and completely insulated except at its point, which forms the electrode, but it is a difficult and dangerous instrument until the operator has had some experience with it. Care must be taken in diathermy of growths near the ureteric orifice lest subsequent reactionary swelling should produce a ureteric block.

Large growths are best removed by suprapubic operation. The patient is placed in the Trendelenburg position, and after opening the bladder its walls are retracted widely by a Thomson-Walker or Morson bladder retractor. The surface of the growth is then destroyed by diathermy to try to avoid implantation growths. If there is a long pedicle, this is transfixed and tied as close to the bladder wall as possible. If the base is sessile, however, a cuff

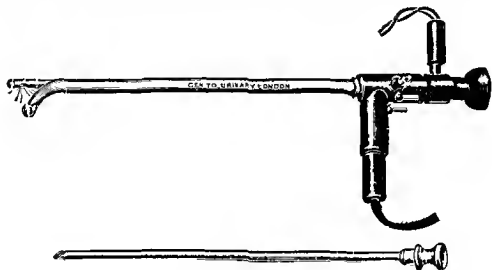


Fig 162  
Kidd's diathermy cystoscope

of mucous membrane is dissected up round the base of the growth, this is then transfixed and tied and the growth removed, the mucous membrane being stitched together to bury the transfixed base.

Suprapubic operation may be necessary in cases of serious or persistent bleeding and in some cases of clot retention. When the papillomata are very numerous it may be advisable to open the bladder and destroy them by diathermy. Complete excision of the bladder with transplantation of the ureters into the colon has been advocated for multiple papillomata when masses of growths fill the bladder.

### MALIGNANT GROWTHS OF THE BLADDER

**Ætiology**—Chronic cystitis and persisting papillomata are precancerous conditions. Carcinoma of the bladder is also seen occasionally with vesical calculi and may arise in a chronic fistula of the bladder.

**Symptoms**—The onset is insidious, the first symptom generally being hæmaturia. The blood may be evenly distributed in the urine or may be mainly at the end of micturition, and clots are common. The bleeding occurs with increasing frequency, and finally becomes continuous. Sometimes frequency of micturition, both day and night, is the first symptom, this eventually

becomes constant and, later, urgency and strangury may occur. Pain is not often an early symptom, it is referred to the end of the penis towards the end of micturition. Later, with nerve involvement it may occur in the supra pubic region, groin, perineum, or anus, and down the thighs. Sooner or later infection follows, pain and frequency become worse and the urine is found to be purulent. Infection may occur before hæmaturia has been observed, all cases of persisting cystitis, therefore, should be cystoscoped. There may be difficulty in micturition when the growth is large or when it is growing near the internal meatus. With the deposit of phosphates small stone fragments may be passed.

**Complications**—Apart from hæmorrhage and clot retention these are mainly due to extension of the growth and infection. Extension towards the internal meatus may result in retention and infiltration of the sphincter may produce incontinence. If one ureter is obstructed there will be renal pain and hydronephrosis. If both ureters are obstructed anuria results. Infection which frequently follows instrumentation will be heralded by increased frequency, dysuria, fever and pyuria, and may end in ascending pyelonephritis. Loss of weight and strength may occur in later stages when death from renal complications and uræmia has not already supervened.

Entero vesical and vesicovaginal fistule are rare, as is also rectal involvement.

**Situation, course and spread**—The lymphatics of the bladder arise in an intramuscular network and a superficial network on the outer surface. Trunks from these drain into the external and internal iliac glands. Those from the anterior surface and upper part of the posterior surface drain into the external iliac chain—lying between the crural ring and the bifurcation of the common iliac arteries. Those from the middle portion of the posterior surface run directly backwards to glands on the promontory of the sacrum at the bifurcation of the aorta, while those from the lower part of the posterior surface and from the internal meatus—with those from the upper surface of the prostate—run along the upper aspect of the seminal vesicles, and along the vasa deferentia to the internal iliac glands. Not infrequently there are interrupting nodes along this chain and these are the first glands to be involved in carcinoma of the bladder base, they may be palpable on rectal examination. Malignant growths originate chiefly at the base of the bladder, the malignant papilloma and the "bald" growth close to but to the outer side of and behind one or other ureteric orifice. Glandular involvement is late and metastases, clinically demonstrable in liver and lungs, are rare. When the peritoneal surface of the bladder is involved spread may be very rapid, and secondary deposits may occur almost anywhere. Death results from hæmorrhage, renal damage, infection and cachexia.

**Diagnosis**—A cystogram may show a filling defect of the bladder (Fig. 163) but diagnosis is established with the cystoscope, when one of the above-described types of growth is seen. Rectal examination may detect an affected gland at the upper and outer aspect of the prostate, and some thickening of the bladder wall may be felt when infiltration is present, or the growth may be palpable bimanually. It must be borne in mind in the case of squamous celled and other infiltrating growths that the cystoscope shows only the intravesical extent of the growth, and that the extravescical part, i.e. the infiltration of the muscular wall, may be much more extensive.

The points suggesting malignancy in a papillomatous growth have been mentioned already in discussing growths of doubtful nature, these are short, stunted villi and a sessile base, ulceration, necrosis and incrustation of the

growth with urinary salts occur only with malignant growths. The presence of puckering or oedematous bullæ round the growth or the presence of out-lying nodules denotes underlying infiltration. Multiplicity of growths is of doubtful significance if several papillomata are present they are probably benign though one may have undergone malignant change so that benign and malignant growths coexist. When a stage of general papillomatosis is reached they are certainly malignant and implantation growths secondary to renal and ureteric growths are always malignant. A growth arising in a diverticulum may be difficult to diagnose unless it projects or can be actually seen inside the opening of the diverticulum. Secondary involvement of the bladder in carcinoma of the prostate and uterus is not uncommon, and intestinal carcinoma may invade the bladder through its peritoneal aspect and produce a vesico intestinal fistula.

**Treatment—PARTIAL CYSTECTOMY**—Operable growths are treated by

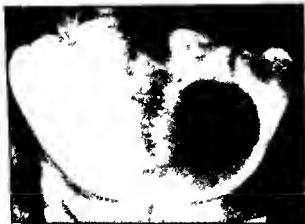


FIG 163

Extensive carcinoma of right side of bladder showing large filling defect. On the right side both the ureter and the kidney were dilated.

partial resection of the bladder. By "operable" is meant a growth which can be removed with a margin sufficient to offer a reasonable prospect of non-recurrence. The general condition of the patient as regards chest, cardiovascular system and renal function must be sufficiently good to warrant operation. "Inoperable" growths are extensive ones and those involving the internal meatus, trigone or both ureters. If one ureteric orifice is involved it is excised with the growth and the ureter transplanted elsewhere into the bladder, this is facilitated by passing a catheter into the ureter with a cystoscope before

beginning the operation. When this is not possible the ureter should be isolated and divided before the growth area is excised. The best exposure is obtained from the Trendelenburg position and the bladder widely retracted by a self retaining illuminated retractor such as Morson's pattern. At least an inch margin of healthy bladder wall surrounding the growth should be excised with it. When it is suspected that the growth involves the peritoneal aspect of the bladder the peritoneum should be opened first for inspection, with peritoneal extension and adherent omentum prognosis is bad, since the largest lymph system of the body is involved. Operation should be followed up as soon as the patient is convalescent with a full course of deep X-ray therapy.

**Total cystectomy**—When the growth is still confined to the bladder, but the bladder wall is too extensively involved for partial resection, total cystectomy with transplantation of the ureters may have to be considered (see p. 209). The operation has a high mortality and the general condition of the patient is rarely sufficiently good to warrant it. The operation should be done in two stages in the first stage the ureters are transplanted into the bowel—usually the lowest part of the sigmoid colon—in the second stage the bladder is excised (Fig. 164).



**Prognosis**—Carcinoma of the bladder untreated is fatal in one to three years as a rule. The most rapidly growing type is the malignant papilloma. The results of partial resection of the bladder in favourable cases offer probably



FIG. 164

Kidneys with rectum and adjacent part of sigmoid two years after transplantation of ureters for vesical papillomata. The kidneys appear to be normal. This patient died of secondaries in the lung and pelvic bones. (Mr. I. Zaclar, J. Cope's case.)

a 30 per cent chance of success. The writer (MacDonald 1930) recorded notes of 140 cases of bladder carcinoma. 39 per cent only were operable and of these 31 per cent were alive and well at the end of three years. Later results suggest this may be rather an optimistic figure including as it does cases which subsequently ran a benign course though pronounced 'malignant'.

by the pathologist On account of this latter doubt statistics are difficult and unreliable

Scholl (1922) recorded results of 166 cases at the Mayo Clinic, but divided them into malignant papillomata and solid carcinomata of the former, 63 per cent averaged three years and three months survival the latter, two years and three months only

**TREATMENT OF INOPERABLE CASES**—This unfortunately, comprises the majority In the writer's experience 60 per cent were inoperable when first seen The two available agents are radium and X-ray Radium can be used either by the implantation of radon seeds through a cystoscope (Smith, 1934) or by the insertion of radium needles round the growth margin with the bladder opened suprapubically The results of radium in certain hands are encouraging Routine X ray treatment of inoperable growths is disappointing, its chief value lies in the relief of pain and hæmorrhage Hæmorrhage when mild but persistent is treated by recumbency and opium the best local hæmostatic for bladder irrigation is a weak silver nitrate solution (1 in 10 000), adrenalin (1 in 1 000) generally is ineffectual cobra venom has been used with success If these fail X ray radiation may be successful When hæmorrhage is severe it may possibly be arrested by blood transfusion, but if this fails the bladder should be opened and drained suprapubically Should clot retention occur the clots may be evacuated by a Bigelow's evacuator, but if this fails or the bleeding continues suprapubic cystostomy is indicated Pain if due to cystitis, is treated by hydrotherapy and urinary antiseptics, lavage of the bladder may help When the pain results from infiltration of the bladder wall or nerve involvement and the usual analgesics fail morphia should not be withheld X ray treatment will often alleviate this pain suprapubic drainage, in the absence of urinary obstruction is of little help Other remedies that may have to be considered are presacral neurectomy, diversion of the urinary stream, either by ureterostomy or ureteric transplantation or insertion of alcohol into the subarachnoid space

**Treatment of growths of doubtful nature**—These must be treated as though they were certainly malignant Decisions may be difficult to make for papillomata occurring in patients of 40 years of age onwards Many of these are benign but it is safer to excise them, if treated by diathermy they must be watched by cystoscopic examination at frequent intervals during the succeeding six months If rapid recurrence occurs or should an ulcer, which does not heal appear at the side of the original papilloma it should be excised forthwith

S G MACDONALD

#### A SIMPLE TECHNIQUE FOR FULGURATION OF BLADDER PAPILLOMATA

An ordinary non irrigating catheterizing cystoscope is satisfactory except for the larger papillomata Progress of the treatment is necessarily slower when such an instrument is used than when one specially constructed for fulguration is employed

For general purposes a cystoscope which embodies the following features simplifies the procedure of fulguration —

- 1 A system for continuous irrigation of the bladder
- 2 Irrigating taps fitted to a rotatory watertight collar,
- 3 A large telescopic field
- 4 A retrograde telescope

- 5 A catheterizing channel which will take a large electrode (No 7 to 8 Charriere),
- 6 An Albarran lever which moves through 135 degrees

A fulguration cystoscope in which the above features were incorporated was designed for me (Winsbury White) and many years of regular use of the instrument have proved these advantages (Fig 16a)

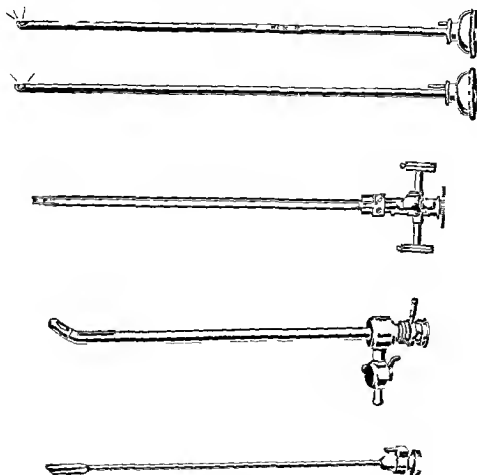


FIG 16a

Winsbury White distending cystoscope with retrograde telescope and double catheterial le

The large-size telescopic field and electrode and the special irrigation system require a calibre for the instrument of 24 Charriere. To attain maximum efficiency of irrigation there is a large bore channel controlled by a single tap which can be turned to regulate inflow and outflow alternately or placed in a neutral position so that circulation ceases.

The Albarran lever is made of bakelite to avoid any tendency to short circuiting of the fulgurating current. This tends to occur through a metal lever in two ways: if the tip of the electrode is too close to it or if the

insulation material near the tip of the electrode is broken. The latter commonly happens from the pressure of the edge of the lever against the electrode. The rotatory collar for the irrigating taps prevents entanglement and obstruction of the irrigation tubes as the cystoscope is rotated. Small size pressure tubing which fits snugly on to the irrigation taps is an extra safeguard which prevents buckling of the tubes. Because the electric light flex is apt to get wet in this procedure a rubber covered one should always be used (Fig 166).

The operation—Unless the papilloma is a very small one the patient should be admitted to hospital so that the treatment may be carried out as thoroughly as is necessary. This routine will result in many cases receiving a complete treatment in one sitting.

A general anæsthetic is preferable to a spinal in a case where the number of treatments for the future is uncertain and may be many.

The lithotomy position is better than the dorsal decubitus for two reasons: a wider range of application of the electrode is possible over the bladder mucosa than in the dorsal decubitus; an aseptic technique is more easily accomplished.

The irrigation reservoir should contain sterile distilled water because any salt in solution as in antiseptic lotions will tend to disperse rather than concentrate the electric current as it leaves the electrode.

If the urine is very blood stained or the bladder is very dirty preliminary washing out with a bladder syringe may be necessary. When the machine made by the Genito Urinary Mfg Co is used the setting of the dial must not exceed 3 with the capacity switch on coagulation. This

applies even when an electrode as large as 10 Charrière is used. Greater strengths will cause necrosis of the bladder wall in certain circumstances and a high concentration of gas bubbles which will obscure vision and unnecessary wear and tear of the electrode. The strong currents should be reserved for Kidd's cystoscope or the button electrode used at open operation when the capacity is also switched on to coagulation.

It is essential to know that after an electrode has been in use for two or three minutes the metal point becomes coated with debris and its conductivity is thereby greatly lessened.

That this change has occurred is apparent from the lessening both in bleaching and in production of gas bubbles at the site of fulguration. It is therefore necessary to work with two electrodes: the instrument nurse cleanses the point of the used one with the edge of a discarded scalpel. The pointed electrode (Fig 167 C) is not only the easiest to deal with in this way but is the most satisfactory for other reasons in most cases. The most suitable size of electrode for use with the above mentioned cystoscope is No 7 Charrière. A size 8 Charrière can be used but it does not move quite freely enough in the instrument to allow quick manipulations; moreover the insulation material of the electrode tends to swell as it gets heated during use and this increases still further the difficulty of manipulation. It simplifies matters to place the tip of the electrode on the point to be fulgurated before connecting the outer

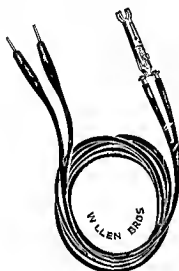


FIG 166  
Reinforced rubber covered  
flexible cystoscope lead

end of the latter with the cable from the machine an assistant should do this

In employing the fulguration cystoscope already referred to the following technique assures rapid progress of the operation. As soon as the bladder is sufficiently filled the tap is turned to the mid position so that there is no circulation of the fluid through the instrument and fulguration proceeds. As soon as vision in the field tends to be obscured a good view is quickly restored by turning the tap first to outflow then to inflow and finally to the neutral position. These manipulations take only a few seconds and safeguard against over distension.

In exceptional cases there is a good deal of bleeding at the end of the operation where this occurs it is wise to tie in a catheter so that frequent vesical irrigation can be carried out for forty eight hours or so. Sometimes this procedure is necessary to lessen bleeding before fulguration is commenced.



FIG 167

Flexible diathermy electrode showing different types of tips

When a large growth is present and a further fulguration will certainly be necessary this should be carried out about a month later unless a reaction has followed the former treatment when two months should be allowed to elapse before repeating the treatment.

H P WINSBURY WHITE

### RADIUM TREATMENT OF BLADDER CARCINOMA

The choice in the method of treating carcinoma of the bladder is of necessity influenced by the extent, location and physical characteristics of the tumour as revealed by the diagnostic cystoscopic examination. The fact that some 75 per cent. of all bladder tumours are situated in the lower zones, on or adjacent to the trigone, rules out the possibility of segmental resection in a very large proportion of cases. As total cystectomy with ureteric implantation can only be offered to a limited number of these fit to undergo this most radical of operations, there remains considerable scope for the alternative method of treatment by radium. In explaining the various phases of this form of treatment for bladder cancer, excerpts from my article on *Radium Treatment for Carcinoma of the Urinary Bladder* (1944) (6) will be given.

**Type of tumour suitable for radium treatment**—Any primary epithelial tumour of the bladder which because of its size or location is deemed inoperable can be treated by interstitial radiation. It is not to be inferred from this that irradiation is a second best to segmental resection. Indeed even with extensive resection planned so as to include the removal of a wide surrounding margin of apparently healthy bladder wall, the end result is all too frequently a recurrence. So impressed am I by this high incidence of recurrence after partial cystectomy particularly when applied to growths in the

neighbourhood of the base that I now prefer to use interstitial radiation in this situation. If the radiation succeeds in destroying the tumour, the average period of freedom from recurrence and the possibility of permanent cure will be greater than after partial cystectomy. Thus, the sessile, broad-based, infiltrating papillary carcinomata occupying the lower zones of the bladder, as well as the ulcerative and nodular growths in this situation, are particularly suitable for radiation. I have not considered it necessary to use radium on tumours with a pedicle even though the size of the growth has necessitated a suprapubic approach in preference to the perurethral route.

Although the size of a tumour has no relation to its curability by radium, the size of the base has. It is useless to employ radium for the diffuse infiltrative type of growth involving perhaps half or more of the bladder.

**Pre-operative investigation and preparation**—A diagnostic cystoscopic examination having revealed a tumour suitable for radiation, the following preliminary measures should be carried out before operation. An intravenous urographic examination is made to ascertain the condition of the upper urinary tract. Dilatation in one or both ureters and renal pelves may be revealed, particularly if the tumour overlies a ureteric orifice. Evidence of impaired renal function and of pyelonephritis resulting from urinary infection is not infrequently present and indicates at least a short period of forced diuresis and appropriate urinary antiseptic treatment or one of the sulphonamides. The intravenous cystogram will frequently give a pictorial representation of the position of the growth by exhibiting a filling defect. If an X-ray of the chest and of the upper femora is made at the same time as the urographic examination, the areas most liable to metastases will all have been included in the radiological examination. As the minimum of instrumentation is desirable, retrograde cystography is not performed nor is pre-operative urethral catheter drainage and lavage carried out except in very infected bladders or in those with a large residual urine due to the coincident presence of an obstructing prostate.

**Operative technique**—Spinal anaesthesia is routinely employed. Before commencing operation, the bladder is emptied by catheter and the patient placed in the Trendelenburg position. A median suprapubic extraperitoneal exposure is made the incision extending down to the symphysis. There is no difficulty in recognizing the extraperitoneal surface of the emptied bladder, stroking the peritoneum upwards by gauze and then opening the viscus in the middle line between tenaculum forceps. Any urine lying on the floor of the bladder that may have escaped evacuation by catheter can now be removed by suction and spilling into the wound avoided. A full exposure of the bladder interior is obtained with the aid of a self-retaining retractor. The Joly type is particularly suitable as the position of the blades can be varied according to the site of the growth.

If the growth is a papillary one the projecting portion down to the level of the mucosa is removed by endothermy. If the tumour can be elevated from off the bladder wall, a needle electrode activated by a cutting current is passed through the mucosal attachment and the whole mass thereby completely excised. In the majority of the cases this manoeuvre is not possible owing to the extent of the tumour base and its fixation to the underlying bladder wall. The protuberant portion has to be reamed off by a loop electrode or diathermied by a blunt electrode and the coagulated tumour scraped away, down to the level of the mucosa. Any bleeding points on the resultant surface are controlled with the diathermy current. The base and surrounding tissues are thus fully exposed to receive the radium.

The distribution of radium should be planned so as to give within the limits of practicability a homogeneous irradiation to the tumour base and its bed. The system recommended is that developed by Paterson and Parker (1934) and described for application to the bladder by Hutchison (1935). A dose of approximately 7000 r is given in each case. The areas treated are generally circular or nearly so and include the whole tumour bearing area with a margin of about 1.0 cm of healthy tissue around it.

The radium needles I use have an intensity of 1.0 mg radium element per cm of active length and are screened with 0.5 mm platinum. In practice it has been found most convenient to use needles containing 1.0 mg and 0.5 mg radium these having a total length of 2.0 cm and 1.5 cm respectively. The radium is distributed in the form of a single layer implant occasionally in square or rectangular outline but most often circular. For a circle 3.0 cm in diameter a single 1.0 mg needle is placed at the centre and six 1.0 mg needles round the periphery. For larger areas concentric circles are used with a central spot. For example in a 5.0 cm circle 70 per cent is placed around the periphery 3 per cent at the centre and the remainder in a circle of half the diameter the interval between circles being 1.25 cm. Such an arrangement is designed to give a uniform distribution of radium at a depth of about 0.5 cm below the mucosal surface. Needles are left *in situ* for a period of 120 to 200 hours according to the extent of the lesion thus giving a radiation of relatively low intensity.

As an alternative to radium element should this not be available radon seeds can be used. Seeds with a filtration equivalent to 0.5 mm platinum with a strength of 1 to 1.5 mc for the outer circle and 0.5 to 0.75 mc for the inner according to the size of the implant are suitable. They also should be inserted 0.5 cm below the mucosal surface and placed 1 cm apart (see Fig 168 A B and C).

When the insertion of the radium has been completed the bladder is closed though not completely. The threads of linen attached to the eye of each radium needle are together delivered through the upper extremity of the bladder incision along with a tube of the Malecot type. The bladder wall is closed up to the tube and threads by a continuous

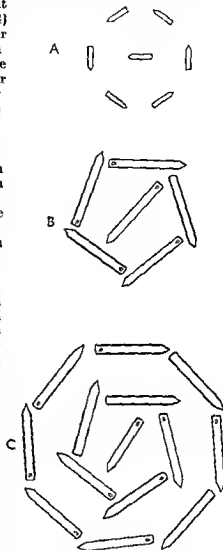


FIG 168

A Seeds in circle of diameter 3 cm. In centre 1 x 0.5 mc in centre 1 x 0.5 mc time 7000 hours (1856 hours) dose 6660 r. B Needles in circle of diameter 3.5 cm. In centre 1 x 1.0 mg in centre 1 x 1.0 mg time 168 hours (1856 hours) dose 6300 r (7000 r). C Needles in circle of diameter 5 cm. In a central ring 8 x 1.0 mg in inner ring 6 x 1.0 mg in centre 1 x 0.5 mg time 168 hours (1910 hours) dose 6130 r (7000 r).

Ten other patients who had been treated from one to six years previously were symptom free but were unable or unwilling to report for cystoscopic examination

Of four patients who died from causes unconnected with the bladder three were almost certainly tumour free One died six years and nine months after operation from a naso pharyngeal tumour a second in four and a half years from cardiac failure and a third who was killed whilst at work in three years and ten months Cystoscopy in each had shown a tumour free bladder at some period after operation and there had been no recurrence of bladder symptoms

Three patients in the series were untraced

ARTHUR JACOBS

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## CHAPTER XXX

### FOREIGN BODIES IN THE BLADDER

**A** MULTITUDE of objects have found their way into the urinary bladder

#### ÆTIOLOGY

A foreign body must enter either by way of the urethra or through the bladder wall the former is the commoner route



FIG 169

Fœtoma nozzle in bladder of woman aged 37 who had endeavoured to interrupt an early pregnancy. Nozzle removed per urethram through operating cystoscope

**Entry per urethram**—This may occur as a result of a number of different circumstances

**FOLLOWING THE PASSAGE OF SURGICAL INSTRUMENTS**—Pieces of catheters or bougies may be broken off and left behind

**ACCIDENTALLY IN WOMEN**—Elongated objects such as crochet hooks, sewing needles, slate pencils, etc (Fig 169) with the purpose of introducing them into the uterus in attempts to procure abortion, often enter the urethra and end up in the bladder

**SEXUAL PERVERSION**—In young people of both sexes various objects are introduced for the purpose of producing erotic sensations bougies catheters straws feathers bootlaces string chewing gum wax tallow etc. Such pliable bodies as the above are more commonly found than solid objects like lead pencils slate pencils crochet hooks etc. but the latter also enter the bladder under the same circumstances.

**Entry through the bladder wall**—**FROM OPERATIONS ON THE BLADDER**—Pieces of gauze etc. or rubber tubing may be left in the bladder at the end of an operation or a piece of tubing may later enter through a fistula and become lost in the bladder.

**MIGRATION FROM AN EXTRA URINARY SOURCE**—This is a commoner method of entry than the former. A needle (Freeman 1885) and a bullet (Penhallow 1932) have been known to enter from the intestine and the rectum respectively. A number of cases are on record in which gall stones (MacDonald 1923 and Adrian 1933) have been recovered from the urinary bladder or passed per urethram. Concretions from the appendix have migrated in the same way.

Unabsorbable sutures and ligatures (Fig 170) and gauze used in extra urinary pelvic operations and even after operations for inguinal hernia may enter the bladder. A foreign body placed in the vagina may cause ulceration and thus enter the bladder giving rise to fistula and stone (Lunham 1925). Other foreign bodies from the pelvic region are sequestra from bone infection of the pelvic girdle the contents of ruptured dermoid cysts.

Pieces of projectiles after lying in an extravescical position for years have been known eventually to enter the vesical cavity.

**ENTRY AS A RESULT OF VIOLENCE**—Pieces of clothing bone other tissue or a projectile may come to rest at once in the bladder especially from injuries received in war time. Objects arriving in such a way may escape detection until attention is attracted to the bladder by the development of special symptoms (Legueu 1917). There may be a delay of years before the foreign body enters the bladder. A piece of knife blade which had entered the right hip region twelve years before formed the nucleus of a large vesical calculus (Judd 1916).

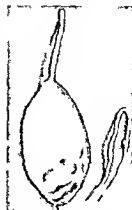


FIG 170

Vesical calculus formed on unabsorbable thread and a piece of suture material removed from the bladder of a woman aged 37 upon whom Case can section had been performed 7 years before.

### PATHOLOGICAL ANATOMY

**The foreign body**—Small mobile foreign bodies remain on the bladder base. Elongated bodies which can arrange themselves transversely generally do so and remain in this position (Fig 169). A long pointed object like a hatpin which of necessity has been introduced head first is usually fixed as a result of the point having penetrated the tissues round the bladder neck, the other end resting on the posterior wall. Catheters laces and similar pliable objects coil up in the interior. Hairpins may be fixed by projecting only partly from the urethra or because the points have entered the bladder wall. On the other hand these may be quite free in the bladder. A piece of projectile may be completely or partly buried in the bladder wall.

The length of time during which a foreign body can remain in the bladder without becoming encrusted with salts varies within very wide limits. In certain cases the foreign body has remained for many years in the bladder, and on removal has been found to be still free from incrustation. The more usual course is for the object to become rapidly coated with salts. The reason why there should be a rapid deposit in one case and not in another is not always clear. Smooth objects seem to resist deposit longer than rough ones.

The time of onset of infection in the bladder is probably the most important factor, and this in some cases depends upon the amount of local trauma of the vesical mucosa caused by the foreign body. Steinitz (1879) reported a case in which a rubber catheter which had been in the bladder for seventeen years was passed spontaneously following dilatation of the urethra.

Largely as a result of infection phosphates (calcium phosphate and ammonio magnesium phosphate) predominate among the salts which are found on foreign bodies. Uric acid and urates occur less frequently.

The bladder—According to the nature of the foreign body there may be little or no damage to the bladder wall. On the other hand trauma and cystitis may occur fairly rapidly. When the point of a foreign body enters the bladder wall it is likely to cause infection with abscess formation in the extravescical region in question. The peritoneal cavity and intestines may be involved in this way, resulting in due course in vesico intestinal fistula.

On the other hand, a foreign body outside of the bladder may produce an abscess which discharges pus and the foreign body into the bladder.

### SYMPTOMS AND SIGNS

The length of time during which a foreign body can remain in the bladder without causing marked symptoms varies within wide limits. In some patients distress is immediate and intense, in others foreign bodies have been known to be present for years and have produced no symptoms at all. The symptoms may be regarded as having a direct relationship to trauma, infection, and complications. At the one extreme the symptoms may suggest a mild simple cystitis, and at the other all the distress suggestive of vesical tuberculosis.

According to the complications which may arise from the foreign body, so there may be evidence of peritonitis, abscess, fistula, incontinence of urine, etc.

### DIAGNOSIS

The withdrawal of a catheter or a bougie, which was passed into the bladder intact, with part of its vesical end missing, may be regarded as strong evidence that a portion of the instrument has been left in the bladder.

In all circumstances, however, whether a foreign body in the bladder is suspected or not, the presence of symptoms of vesical disease will call for *cystoscopy*. This examination is essential, not only for the purpose of identification but as a means of deciding upon treatment. With an irritable bladder an anæsthetic may be required. If the foreign body is completely surrounded by calculous deposit, it may not be visible with the cystoscope. In a young girl in this part of the world a vesical calculus is so unusual that its presence should at once call to mind the possibility that the stone is the result of a foreign body. Where such a question arises it is important that this point should be finally settled before treatment is decided.

*Radiography* will occasionally demonstrate that a foreign body is present sometimes as the nucleus of a vesical calculus. The X ray appearance may

indicate the composition of the foreign body. A substance which is not opaque to X rays will appear as a clear area within the stone.

*Exploration of the bladder with a sound* may in the first instance reveal the presence of a foreign body which however may quite easily escape detection by this means and thus must therefore be regarded as unsatisfactory as a method of diagnosis.

*Vaginal or rectal examination* may suggest the presence of some object in the bladder whereupon a full investigation will be required.

### TREATMENT

The extraction of foreign bodies may be accomplished by way of the urethra or by incision.

*Extraction per urethram*—Every consideration should be given to the possibility of removing the object by this route. According to whether the patient is a male or a female each foreign body having regard to its nature and its relationship to the formation of stone creates its own problem.

**A BODY WHICH HAS NOT GIVEN RISE TO STONE**—*In women*—Many foreign bodies can be removed by way of the urethra after all the features of the case have been studied carefully. Where special instruments are lacking it may be possible to dilate the urethra sufficiently to introduce a finger which can control the points of a pair of forceps so that the instrument may be made to grip the object in such a manner that it can be withdrawn. Fortunately under modern conditions circumstances necessitating this crude method of treatment are unlikely to arise.

In the case of a smooth thin object such as a thermometer or a crochet needle it may be possible by bimanual manipulation in a woman to direct one end of the object into the urethra. Long supple objects such as straws, laces and catheters can generally be seized and extracted with a lithotrite. In order to deal with a hairpin through the operating channel of a cystoscope a wire is passed carrying a terminal hook (Legueu hook) which can easily engage the loop of the hairpin. The hook is drawn as far as possible into the cystoscope which is then withdrawn carrying the pin with it.

When any of the foregoing procedures do not succeed or cannot be carried out there are two cystoscopic instruments which can be employed with every prospect of success—flexible rongeur forceps which can be passed through the single channel of an operating cystoscope, the cystoscopic rongeur (Fig 447). The former instrument can grasp one end of a slender object, the loop of a hairpin or a supple object such as a bootlace, a piece of thread or straw. The cystoscopic rongeur can do all these things and in addition can firmly grasp one end of larger elongated objects than those just referred to. Once the object is seized the grasp is not relaxed while the telescope is removed and the rongeur with the foreign body is then removed.

*In men*—Sometimes a small object can be passed per urethram after urethral dilatation with sounds. The same rules apply as for females with the cystoscopic instruments. The cystoscopic rongeur is particularly useful in the case of very small foreign bodies and after failure with a lithotrite.

**A BODY WHICH HAS GIVEN RISE TO STONE**—Extraction of such an object per urethram is only possible after the stone has been crushed with a lithotrite. This is perfectly practicable where the foreign body consists of a ligature, chewing gum or some other pliable substance which can be either grasped with the lithotrite or evacuated with the stone fragments. With elongated or pointed objects there is too much danger of causing serious injury to the

bladder wall to attempt this method. It is far better to remove the stone and its cause by suprapubic incision as a primary procedure. In women more particularly stones or ligatures and other small objects may be passed spontaneously especially after urethral instrumentation.

**Extraction through a suprapubic incision**—It may be necessary to resort to this method after an unsuccessful attempt per urethram. If there is likelihood that much trauma has been caused by the urethral manipulations it is wise to proceed at once to open the bladder so that adequate suprapubic drainage can be established as soon as the foreign body has been removed.

In other cases the suprapubic incision will proceed forthwith as a primary procedure. It will be necessary in the following circumstances. One end of an elongated object has penetrated the bladder wall, the body is the wrong shape for extraction per urethram, a stone has formed on the object which renders litholapaxy an unsuitable procedure, the presence of intense cystitis makes perurethral manipulations unsuitable.

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# CHAPTER XXVI

## FISTULÆ OF THE BLADDER

### SUPRAPUBIC VESICAL FISTULA

A SUPRAPUBIC fistula is generally a sequel to an earlier suprapubic operation. The cutaneous opening is usually located at the lower end of the scar and unless drainage by tube has been maintained is of pin point size. The entire urinary output may come through this opening or some of it may be passed through the urethra. A fistula of this type must be deemed persistent if closure does not occur within a reasonable period after the original

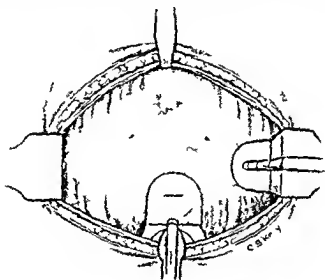


FIG. 171  
Bladder after exposure to show a stenosed internal meatus  
causing a recurrence of obstruction after prostatectomy

operation or if reopening takes place and continues after the bladder has closed and the patient has voided satisfactorily.

**Ætiology**—The operation that is most frequently responsible for a suprapubic fistula is prostatectomy inadequately performed. Thus part of the gland may not have been removed or valvular folds of mucous membrane or adenomatous nodules may have been left in the prostatic cavity. Fibrous tissue may form in the cavity and prevent the bladder from closing or cause it to reopen (Fig. 171). Failure to control urinary infection before and after operation particularly if this results in the formation of secondary phosphatic calculi may cause a fistula. These complications are most likely to follow the blind operation of prostatectomy as described by Freyer (1901).

A stricture of the urethra which has been overlooked may prevent a resump

tion of normal micturition. An insufficient perurethral prostatic resection which has been preceded by a suprapubic cystostomy is almost certain to be followed by a non closure of the bladder. Failure to relieve a prostatic obstruction owing to the enlargement being malignant or recurrence of the obstruction from that cause may result in a fistula.

It will be observed that the predominant factor responsible for the fistula formation as outlined above is a failure to remove completely the obstruction

at the vesical outlet. Cases of persistent fistula after prostatectomy may occur however even when no obstruction remains. This can be due to adhesion of the bladder to the abdominal wall and to the posterior surface of the symphysis pubis or to an extension of the vesical mucosa into the fistula (Fig 172). It is most likely to follow a two stage operation particularly when the preliminary cystostomy opening has been maintained over a long period and is in too close proximity to the symphysis. An additional predisposing cause is the removal of the prostate through a downward extension of the cystostomy opening without resecting the fistulous tract and freely mobilizing the bladder. Delayed healing is also encountered in feeble old patients particularly those suffering from severe arteriosclerosis and from diseases of the central



FIG 172

Prolapsing vesical mucosa at site of suprapubic fistula

nervous system. A further non obstructive cause of fistula after prostatectomy is the presence of one or more diverticula which have not been removed before or during the prostatectomy.

Carcinoma of the bladder operated on through the suprapubic route with the object of destroying the growth by diathermy or radium may if the growth is not successfully controlled by these means be followed by a persistent fistula. Even if the bladder heals after operation extension of the growth may result in a subsequent reopening of the wound through which the tumour can infiltrate. Extension through the abdominal wall of a bladder growth which has not been subjected to operation with consequent fistula is rare. Few patients so affected survive long enough for this to occur.

A suprapubic fistula may have its origin in a secondary tuberculous cystitis. The incidence of this complication is however low. With an experience of some hundreds of cases of renal tuberculosis suffering from variable degrees of secondary cystitis some so advanced that the bladder capacity was almost nil I have not observed it.

**Clinical examples**—From a series of cases of persistent suprapubic fistula which the writer has had to deal with the two following are quoted as typical examples.

A patient aged 69 who had worn a suprapubic tube for eight years sought advice on account of increasing suprapubic discomfort. He gave a history of a prostatectomy having been performed fourteen years earlier. A resumption of normal micturition had followed the operation but the act had never been entirely free. During the ensuing six years the bladder had been reopened on three subsequent occasions and multiple calculi removed. At the last operation permanent suprapubic drainage had been established and no urine had been

voided through the urethra since Two years before presenting himself he had submitted to a perurethral resection by the 'punch' method but this had failed to restore micturition Examination showed that a large median and right lateral lobe of the prostate were present in addition to a small phosphatic vesical calculus Removal of the stone and the remainder of the prostate gland through a small downward extension of the suprapubic fistula failed to restore normal urination Later the fistulous tract was resected and the bladder freely mobilized and re-sutured a small drainage tube being inserted for a week Normal micturition followed the wound being completely dry within four days of removing the tube

This was an example of an inadequate prostatectomy, only the left lateral lobe having been removed at the original operation Recurring vesical calculi developed as a result of urinary stasis and infection and suprapubic drainage was ultimately deliberately established because of this the continued presence of a prostatic obstruction having been overlooked When discovered some years later an unsuccessful attempt was made to deal with it by a perurethral resection Even a complete removal of the gland still left the patient with a suprapubic leak until finally the fistulous tract was resected and the bladder mobilized

A patient aged 68 with a suprapubic fistula of eighteen months duration was experiencing persistent perineal and suprapubic pain and difficulty had recently been encountered in reinserting the suprapubic tube Two years earlier he had had a one-stage prostatectomy This had been followed by an apparently satisfactory result normal voiding occurring within two weeks of operation and the bladder closing shortly after Within a few months however he began to have increasing difficulty with micturition which the repeated passage of bougies did not alleviate Six months after prostatectomy he had a complete retention and the surgeon finding it impossible to pass a catheter was compelled to establish suprapubic drainage Investigation of this patient revealed the bladder cavity to be almost filled by two large calculi and a complete occlusion of the vesical outlet to have occurred Normal micturition was restored by an open bladder operation the fibrous tissue which was occluding the outlet being dissected away and the internal meatus reconstructed

The gradual occlusion which followed the prostatectomy in this case was due to an extreme form of fibrous contraction occurring at the site of enucleation of the gland

**Treatment**—The urological surgeon is not infrequently called upon to deal with cases of persistent suprapubic fistula An investigation should first be made to ascertain if any obstruction remains A rectal examination may confirm an incomplete removal of the prostate The existence of a urethral or bladder neck obstruction will be ascertained by the passage of a bougie and examination with the appropriate cystoscope will reveal any intravesical cause that may be responsible for the non closure of the bladder In some cases where no obstruction exists simple curettage of the fistula followed by a few days urethral catheter drainage will suffice to effect a cure In many instances however it will be necessary to excise the fistulous tract A linear incision is made the middle of which circumscribes the opening The anterior wall of the bladder is exposed on each side of the tract as well as above and below it When carrying the dissection upwards an endeavour should be made to avoid opening the peritoneum If this occurs it should be adequately freed and closed by catgut suture The opening into the bladder should be enlarged, preferably upwards but again avoiding the peritoneum If there is an obstruction at the vesical outlet to be dealt with a careful digital examination of this area is now made A hypertrophied prostatic lobe may have to be



enucleated or a fold of mucous membrane or an intra urethral nodule of prostatic tissue cut away. A severe contracture at the prostatic orifice which—as in several cases which I have encountered—may have progressed to a complete occlusion will require open dissection. A good exposure and illumination of the vesical outlet is obtained by a self retaining bladder retractor. The fibrous ring is grasped by forceps cut backwards in the middle line and the scar tissue cut away round each side of the internal meatus (Thomson Walker 1927). Interrupted sutures of catgut are passed through the rim of the large opening thus obtained. If the meatus has been completely obliterated it is necessary to pass a metal bougie from the urethra and cut on it from the bladder surface as a preliminary to the dissection. The bladder wall is now closed up to a small suprapubic drain delivered from the upper angle of the bladder incision. A catheter is retained in the urethra for about a week.

In the less severe grades of obstruction when it is possible to pass a resectoscope a perurethral resection of the obstructing tissue is the method of choice. It is surprising how in such cases the removal of a small amount of tissue will result in a complete restoration of normal micturition and the early closure of what was previously a persistent fistula.

### VESICOVAGINAL FISTULA

**Ætiology**—The majority of vesicovaginal fistulae develop as a result of obstetric or surgical trauma. In difficult labour due to disproportion between the pelvis and the presenting part or from abnormal presentation the vesico vaginal septum is compressed against the back of the symphysis pubis. If this occurs over a prolonged period the tissues undergo necrosis and about the fifth day of the puerperium a slough begins to separate and urine dribbles into the vagina. If compression occurs before the cervix is pulled up over the head the cervical tissue may be involved and the resulting fistula will be a vesico cervico vaginal one. The posterior segment of the urethra is often involved in the sloughing. Direct injuries to the bladder by forceps cranioclast or the perforator may also occur during the operative procedures used at delivery.

Of surgical trauma hysterectomy is the most frequent cause. The bladder may be directly injured at the operation or an area of necrosis can result from interference with the blood supply of a local area of the bladder. A fistula may also in rare instances follow a vaginal plastic repair. With the improvement in obstetric practice the incidence of post obstetric fistula is decreasing but there is an increase in surgical fistulae coincident with the greater number of operations now carried out on the pelvic organs.

Carcinoma of the uterine cervix and carcinoma of the bladder with invasion of the vesical vaginal septum may result in fistula and radium treatment employed to control such malignancy may be responsible for secondary fistula formation. Comparatively rare causes are foreign bodies or stone in the bladder foreign bodies in the vagina for example a pessary vesical tuberculosis and rupture of a perivesical abscess.

**Diagnosis**—The patients will generally have a history of a recent obstetric or gynecological procedure. There is a leakage of urine from the vagina. The vaginal walls are usually inflamed and the external genitalia excoriated. In some instances most of the urine is voided normally this occurring when the fistula is small and highly situated. A digital examination will reveal the site of the fistulous opening through which it may be possible to pass the examining finger into the bladder. Examination with a speculum will help to demonstrate the smaller openings the presence of scar tissue acting as a guide. If the

opening is hidden by folds of mucosa its site can be defined by instilling fluid coloured if necessary by indigo carmine through a catheter passed through the urethra and the efflux coming into the vagina is observed. A cystoscopic examination will show the size of the vesical aspect of the opening and its relationship to the ureteric orifices. Except in those instances of very gross destruction of the septum enough fluid can usually be retained in the bladder for the purpose of cystoscopy particularly if an irrigating cystoscope is used.

Incontinence resulting from a ureterovaginal fistula also a sequel to hysterectomy or labour is diagnosed by passing a ureteric catheter up the affected ureter. The catheter will be obstructed at the site of the fistula. Indigo carmine injected through the catheter will appear in the vagina whereas if the dye is injected into the bladder it will not be returned. Both types of fistula may be simultaneously present.

**Treatment.**—A period of two months should elapse before operative repair of the fistula is attempted. This allows time for the complete involution of the pelvic organs and confirms that spontaneous closure will not take place. The approach may be either through the suprapubic transvesical or vaginal route. Every effort should be made before either method to treat any accompanying cystitis and to sterilize the urine. Local hygienic measures are employed for the vagina and the surrounding skin, if excoriated.

**THE SUPRAPUBIC TRANSVESICAL OPERATION.**—The suprapubic operation is that favoured by urological surgeons and is the method of choice for all fistulae except those located near the neck of the bladder. Fistulae situated high up in the vagina and that will include the greater number of post operative fistulae are more easily accessible by the suprapubic route and a good exposure is essential for success.

The bladder is exposed through a mid line incision extending upwards from the symphysis for 3 to 4 in. The recti muscles are separated and the extraperitoneal antero-superior wall of the empty bladder is pulled upwards. After reflecting the peritoneum the bladder is opened in the middle line without entering the peritoneal cavity. Traction sutures are passed through the lips of the bladder incision and a bladder retractor is now placed so as to give a full exposure of the opening. If this is seen to be near the ureteric orifices catheters are passed up the ureters to protect them. The next step is to separate the bladder from the vaginal wall all around the fistula (Fig. 173). The two structures are completely liberated from one another for a distance of about  $\frac{1}{2}$  in. The opening in the vaginal flap is closed with a series of chromic catgut or medium silk sutures and the opening in the bladder by plain catgut inserted so as to invert the mucosa. The bladder is closed in two layers up to a Freyer or Mahcot tube which is inserted through the upper part of the incision. This tube is delivered along with a drain from the space of Retzius through the lower end of the abdominal incision which is closed in layers. On return to bed the patient may occupy the supine or lateral position. Obstruction of the tube by blood clot must be prevented by gentle irrigations with a mild antiseptic. Suprapubic drainage is maintained for about two weeks after which a self retaining urethral catheter may be inserted to hasten closure. The patient is not allowed out of bed until the end of the third post operative week.

**VAGINAL OPERATION.**—This method is preferable when the fistula is low lying in the vicinity of the bladder neck. It was the route used by Sims (1852) in his painstaking and successful endeavours last century and Mahfouz (1938) who has had a unique experience in dealing with an exceptional number of sufferers in Egypt considers that any fistula that is amenable to repair can be dealt with in this way. The fistula can be brought into view by tenaculum

forceps applied to the cervix or to the vaginal walls above and below the edges of the opening. The vaginal flap is freely dissected off the bladder wall around the entire circumference of the opening. The edges of the bladder are approximated by a series of interrupted thirty day catgut sutures which include a good bite on each side but which should not include the mucous membrane. The permeability of the bladder is tested and if there is no leak the vaginal flaps are brought together with silkworm gut sutures. A self retaining urethral catheter is kept in the bladder for seven days. The silkworm gut sutures are removed in twelve days.

**IRREPARABLE FISTULA.**—In spite of all advances in the technique of repairing vesicovaginal fistula a certain number remain intractable and

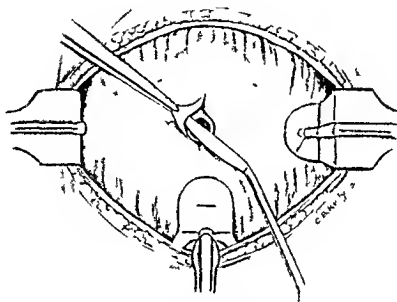


FIG. 173

Self retaining retractor placed in the bladder to expose a fistulous opening situated behind the interureteric bar. The vesical wall is being separated from the vaginal wall.

cannot be closed. After having been subjected to multiple operations these unfortunate patients live in constant discomfort and the effect on the general health and morale is such that they are often impelled to lead the life of a recluse. There is one procedure that can entirely relieve them of the incontinence and restore them to a normal way of life. It is to deviate the urine from the bladder by transplanting the ureters into the pelvic colon. This operation when performed for vesicovaginal fistula has a low mortality rate and the expectation of life is good. There are now records available of patients who are well thirty years after the operation (Stevens, 1941).

### INTESTINO VESICAL FISTULA

**Ætiology.**—Fistulous communications between the bladder and the intestinal tract are generally due to an inflammatory or neoplastic lesion originating

in the bowel. Occasionally the causative lesion lies within the bladder. Enterovesical fistulæ may also result from trauma and a congenital variety is encountered. Craig and Lee Brown (1927) subdivide the non traumatic variety into (1) inflammatory, (2) tuberculous, (3) syphilitic, (4) actinomycotic, (5) echinococcal, (6) amœbic, (7) malignant. Those of inflammatory origin may be due to (a) abscess, (b) diverticulum or diverticulitis, (c) stone, (d) stricture and (e) ulcer.

Fistulæ due to trauma can result from a penetrating wound of the abdomen or perineum or a non penetrating injury that has been followed by sloughing. Leguen is quoted by Kellogg (1938) as having seen sixty cases of bladder wounds following war injuries, twenty of which developed vesico intestinal fistulæ. Practically all healed spontaneously. Surgical trauma may also be responsible. The careless insertion of the trigonal suture in Harris's method of prostatectomy or the unskilled use of the prostatic electrotome can produce a vesico rectal fistula. Intensive radium and X-ray therapy for carcinoma of the cervix or other malignant pelvic lesion can also prove an ætiological factor in the production of those fistulæ.

Fistulæ of congenital origin are associated with imperforate anus. The factors responsible for the arrested embryological development which results in a failure of the cloacal membrane to absorb and form a normal anus may also cause a failure in the formation of the septum between the rectum and the lower genito urinary tract. The consequent anomaly in the male may be a recto vesical or recto-urethral fistula and in the female a recto vaginal one.

**Pathology.**—The posterior wall of the bladder near the trigone or in the upper zone is the most frequent location of the vesical end of the fistula. If the communication is with the pelvic colon or rectum the opening is generally on the left side. On cystoscopy it may appear as a reddened oedematous ulceration, hard to recognize as a false opening unless bubbles of air or particles of faeces happen to escape at the time of the examination. A generalized cystitis is usually present this being most marked in the vicinity of the opening. Should the causative lesion arise in the bladder it will generally be due to a malignant growth, trauma or tuberculosis.

In the abdomen the picture is that of a chronic localized peritonitis. Occasionally only a small area around the fistula becomes adherent between the bowel and the bladder, but oftener the area is extensive and the tissues oedematous and inflamed. In older cases the adhesions may be dense and scar like or there may be an inflammatory mass involving several loops of intestine and the adjacent pelvic structures as well as the bladder. An abscess may be present between adherent structures. To this general inflammatory picture will be added the special features of the causative lesion.

The following primary causes in a series of 42 cases are quoted by Bryan. Sigmoid diverticulitis 15, probable sigmoid diverticulitis, 6, inflammation, 4, surgical trauma 3, carcinoma of sigmoid, 3, carcinoma of bladder 2, carcinoma (not specified), 2, ovarian abscess, 2, amœbic sigmoiditis 1, carcinoma or gumma of sigmoid, 1, tuberculosis, 1, stricture 1, ulceration, 1.

Although the terminal portion of the bowel is the part most commonly involved, other areas are frequently implicated. Pascal (1900), who surveyed 195 collected cases, found that the communication from the bladder extended to the rectum, 113, the colon, 42, the ileum, 26, the cæcum, 6, the cæci and appendix, 1, appendix, 7. More recent statistics favour the sigmoid and not the rectum as the part most commonly involved on the intestinal side. Thus in Kellogg's series, sigmoido vesical fistulæ constituted 63 per cent of the total and recto vesical 16 per cent.

**Symptoms**—The development of an intestino-vesical fistula is usually insidious. There is a deterioration in general health, which is frequently accompanied by loss of weight and mental depression. Pain over the left lower quadrant of the abdomen is experienced and there is a varying degree of tenderness in that area. Simultaneously or shortly following this early symptomatology the patient experiences bouts of urinary frequency and dysuria with perhaps rigors and an elevated temperature. Intervals of a complete remission of symptoms often occur and, as the fistula has not yet formed at this stage it may be difficult to locate the cause of the complaint. Should an abscess between the bowel and the bladder precede the formation of the fistula it may rupture into the bladder, and a large amount of pus will in that event be discharged in the urine just before the onset of the more characteristic symptoms. Sooner or later pneumaturia, that is the passage of gas by the urethra, occurs, and subsequently fecal matter appears in the urine. This may take the form of a few shreds or of quite large masses. Fragments of undigested food can sometimes be recognized, and bile may be present if the fistula is in communication with the small intestine. The escape of gas and fecal matter is often intermittent. One of the author's cases with a fistula due to diverticulitis complained of a bubbling sensation at the end of micturition, once every two to three weeks. Often there is no evidence of urine passing from the bladder into the bowel. Such a passage is most likely to occur when the opening in the bladder is higher than that in the bowel, or of a larger calibre.

**Diagnosis**—Although pneumaturia may occasionally result from the presence of decomposing sugar in glycosuric conditions or from chronic urinary infections by some of the coli groups and by the bacillus aerogenes capsulatus, the escape of air and fecal matter with the passage of urine leaves no doubt that a fistula exists between the bladder and some portion of the intestinal tract.

The vesical opening of the fistula may be located at cystoscopy, when it is sometimes possible to pass a ureteric catheter through it into the track of the fistula. An X-ray, taken after injecting radio-opaque fluid through the catheter, will reveal the section of bowel involved. An X-ray of the intestinal tract after a barium meal or enema will generally show the nature of the underlying intestinal lesion as well as its location, and oblique views may furnish visualization of the fistulous track itself. It is not uncommon to see barium passed in the urine following these examinations. A sigmoidoscopic examination may also demonstrate the nature and site of the bowel lesion.

**Prognosis**—Spontaneous healing, except in certain of the traumatic varieties, is a rare possibility. If the underlying disease is not a fatal one, the condition in a small percentage of cases, may be present for many years without seriously affecting the health of the patient. The majority, however, suffer severely, and deleterious changes quickly manifest themselves.

An ascending renal infection may result in a septic pyelonephritis. Peritonitis and intestinal obstruction are other complications which may supervene. Pascal found that the mean duration of life after the establishment of the fistula was three years. Save for the exceptional case, the prognosis must be regarded as grave.

**Treatment**—The treatment of an intestino-vesical fistula depends on the pathological nature of the underlying cause, and may thus be curative or merely palliative. If the condition is due to a malignant or tuberculous process there is little chance of healing, but if the fistula is of inflammatory or traumatic origin there is a good prospect of cure. The objective is the obliteration

tion of the fistulous track and closure of the vesical and intestinal openings. The abdominal route usually offers the best method of approach. A two stage operation adds to the chance of success as well as to the safety of the procedure if as in the majority of cases the communication is with the lower bowel. The first stage consists in establishing temporary drainage of the bowel by means of a cecostomy or a transverse or inguinal colostomy. The more completely the feces are deviated from the section of bowel in which the fistula is located the greater the subsidence of inflammatory reaction in that part of the intestine. Greater benefit is therefore likely to follow a colostomy than a cecostomy which deviates only part of the faecal current. A transverse colostomy is preferable to an inguinal colostomy as the latter will tend to restrict the abdominal manipulations in the second stage. In addition if for any reason the colostomy requires to be permanent the position of the artificial anus allows it to be more easily cleaned and an apparatus is more easily fitted. The second stage should be delayed until the elapse of about eight weeks after the colostomy. In the interval the loop of intestine involved in the fistula can be cleaned by daily irrigations through the stoma as well as through the rectum. At the second stage the adherent intestine must be separated from the bladder and the fistulous openings in the bladder and intestine closed. Due to the preliminary drainage of the bowel there is commonly a subsidence and limitation of the inflammatory oedema and swelling. Dense adhesions may however require to be dealt with and coils of small intestine may be involved in addition to the sigmoid. It may be necessary to resect the affected portion of the intestine or alternatively a short circuit might be carried out with the object of preventing fecal material from entering the fistula by excluding the affected portion of the bowel. Closure of the colostomy is carried out later.

The perineal approach may be used when the opening is low down in the rectum. It is possible by this route to separate the bladder from the rectum cut across the fistulous tract and suture the openings if these are within 4 in of the anal opening.

When the causative lesion is inoperable or if the patient is old and debilitated operation should be limited to a permanent colostomy. Some patients prefer to avoid the risk of a radical operation and are content to retain the colostomy. The subsidence of the cystitis and recurring pyrexial attacks which follows an effectual diversion of the bowel content from the bladder results in a pronounced improvement in the general well being of the patient.

ARTHUR JACOBS

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## CHAPTER XXVII

### DISTURBANCES OF MICTURITION RESULTING FROM NERVOUS DISEASES AND INJURIES: ATONY OF THE BLADDER

**ÆTIOLOGY**—Many lesions of the nervous system lead to disorganization of micturition. Some such as complete transverse lesions of the spinal cord or complete lesions of the cauda equina, always affect micturition. In others such as tabes, micturition is commonly but not constantly affected.

Transverse lesions of the cord commonly result from myelitis, which is usually syphilitic from injuries of the spine, from tuberculosis of the spine, from secondary growths of the spine, particularly in carcinoma of the breast and hypernephroma of the kidney and from tumours of the spinal cord. In all of these conditions the lesion of the cord may be incomplete and then micturition is not necessarily affected though it commonly is. Cauda equina lesions usually result from injuries to or diseases of, the spine, from spina bifida, or as an undesired result of the administration of a spinal anæsthetic. It is probable that certain localized lesions of the brain stem and cortex constantly lead to defects in micturition, but as these are rare must be bilateral to be effective, and are often associated with gross impairment of consciousness, it is rare to see clear cases of them (see p 234). In this group are pontine gliomata and bilateral lesions of the ascending frontal convolutions in the vicinity of the falx. Possibly many vascular lesions with defects of micturition are in this group, but as in these consciousness is often profoundly affected, and as, from their nature, the lesions are often multiple, this cannot be regarded as certain. The defects of micturition which commonly follow fracture of the base of the skull can seldom be dissociated from affections of consciousness.

In many nervous diseases besides tabes defects of micturition may occur, but do not do so constantly. The most important of these are other forms of syphilis of the nervous system and disseminated sclerosis, in both of which they occur commonly, subacute combined degeneration of the cord and tuberculous meningitis, especially in adults, in both of which they occur occasionally before there is any obvious impairment of consciousness, and poliomyelitis, in which they have been known to occur but are of great rarity.

Affections of micturition are very rare in peripheral neuritis. They may occur as a result of injuries of the pelvic nerves in excision of the rectum (see p 229). The retention with overflow which results from the incarceration of a retroverted gravid uterus is probably the result of pressure on or stretching of the pelvic nerves since the usual symptom is incontinence without pain. It is possible that the retention of urine which is common in typhoid fever may be due to neuritis.

**Symptoms and signs**—All affections of micturition due to nervous lesions which have lasted a considerable time are commonly sooner or later associated with infection of the urine. In many such cases cystitis is severe and may mask the symptoms due directly to the nervous disease. The supervention or exacerbation of cystitis is accompanied, in most cases, by a marked diminution in the volume of residual urine, whether this is of mechanical or nervous origin. Holmes (1933) doubts if this occurs when the urine becomes infected

immediately after the severance of the cord in gunshot wounds but this is obviously difficult to prove. Infections were shown by Head and Riddoch (1917) to diminish reflexes from the part of the cord distal to a transection and so interfere with the symptoms of the lesion in another way.

Complete transverse lesions of the cord can occur suddenly as in injury or myelitis or slowly as in compression from tuberculosis or secondary growths of the spine. In the sudden cases should the patient survive the symptoms are the same as those described in the cat whose cord has been divided (see p. 210) namely retention of urine going on to overflow which passes gradually into automatic micturition. This transition which takes only a few days in the cat takes weeks in man. While the bladder is in the overflow stage it is peculiarly liable to infection should any pathogenic organism even *B. coli* be introduced and for this reason many patients die without passing into the automatic micturition stage. A large volume of residual urine always renders a bladder specially liable to infection but in acute transverse lesions of the cord there seems to be an additional factor this is probably damage to the bladder wall from overstretching which has been prolonged because of the absence of pain. When automatic micturition has been established the passage of urine can be evoked by cutaneous stimuli of the analgesic parts particularly of the penis, scrotum and perineum. The passage of jets of urine is then usually associated with movements of the lower limbs if these are paralysed and these may be very violent. Residual urine is always present but its volume may be small particularly if cystitis is present. As a result of many jets of urine being passed at once when the patient is active he may remain dry for considerable periods when resting.

In cases of slow compression of the cord retention may be preceded by increased frequency of micturition without residual urine followed by difficulty in micturition with residual urine. In some cases of slow compression there is no stage of retention or this is so short that it passes unnoticed.

Lesions of the cord if the conus is intact do not abolish the bulbocavernosus reflex the contraction of the bulbocavernosus evoked by pricking the glans penis but lesions of the cauda equina do. In cauda equina lesions automatic micturition does not occur and the urine dribbles away more or less continuously. Although spina bifida is congenital the associated cauda equina lesion is not necessarily maximal from the beginning and even after the patient has grown up it may progress by roots which have been functional ceasing to be so. In lesions of either cord or cauda equina defecation and erection are likely to be affected if micturition is. It sometimes happens however in cauda equina lesions such as those in spina bifida that erection may be preserved when the bladder is completely paralysed. The possibility of this combination of symptoms must depend on the arrangement of the sacral plexus in each case it can only occur if the highest root of the pelvic nerve carries a large part of the vasodilator nerves to the penis and few or none of the motor nerves to the bladder. When it occurs part or the whole of the fluid emitted on coitus is urine.

The common affection of micturition in tabes is difficulty and increased frequency with a small or moderate volume of residual urine. In more advanced cases there is a large residual urine under very low pressure. The patient then complains of wetting himself particularly at nights when he gets up and strains out small quantities of urine although he has no desire to do so because he has found that this keeps him drier. Incontinence occasionally occurs without residual urine. Prostatic abscess may arise in tabes when there is residual urine with infection.



**Diagnosis**—The proof that a nervous disease is the cause of a defect of micturition depends finally on establishing the presence of a nervous disease capable of bringing about the defect, the means of doing this are not within the scope of this book. When a nervous disease is known to exist, mistakes can be made by assuming that the symptoms of disturbed micturition are of nervous origin when in fact a mechanical cause is present. This error is particularly likely to occur in tabes in which urethral stricture is fairly common. When a patient with a nervous disease has infected urine, secondary stones may form in the bladder or kidneys.

To differentiate the cause of a considerable volume of residual urine which has lasted a long time, there are certain manifestations by which cases of nervous origin differ from those of mechanical origin other than in showing physical signs of nervous origin unrelated to the urinary tract —

- 1 A large residual urine is under a very low pressure, which is obvious without any special apparatus to measure it. This condition sometimes occurs in mechanical obstructions, such as the silent form of semile enlargement of the prostate, but does not occur in most.

- 2 A large residual urine produces a much less evident enlargement of the bladder on abdominal examination than an equal volume due to a mechanical cause.

- 3 The blood urea is seldom raised to the extent that would be expected from the volume of residual urine and the duration of the symptoms had the cause been mechanical.

- 4 Nervous diseases never lead to coarse trabeculation of the bladder or to the formation of diverticula.

- 5 The posterior urethra may be so widely open that a good view of the verumontanum can easily be obtained with an ordinary Nitze cystoscope. This observation is not of much use unless the cystoscopy has been done without an anæsthetic, and for obvious reasons is useless if it has been done under a spinal anæsthetic. In a conscious patient and in the absence of any anæsthetic it is useless if the patient has a strong desire to micturate at the time. This is perhaps the most important urological sign in a neurological condition, since the cystoscopic findings are exactly the reverse in Marion's bladder-neck disease, which is the mechanical condition most likely to be mistaken for a neurological one.

**Treatment**—For the purpose of treatment, nervous disorders of micturition divide themselves naturally into two groups according to whether they are acute or chronic.

**ACUTE STAGNATION**—Most cases of traumatic lesions of the spinal cord which die after surviving more than a few days do so from pyelonephritis arising from infection introduced into the bladder. In many cases this is due to the adoption of some complicated method of treatment designed to avoid all infection, whereas a simple method not so designed but giving efficient drainage of the bladder and thereby minimizing the results of infection would have been successful more often.

The methods which have been tried are expression of the bladder, tying a catheter into the urethra, intermittent catheterization and suprapubic cystostomy. In choosing a method of treatment it must be remembered that some patients with acute spinal lesions which have at first all the signs of complete lesions, may completely or partially recover, this is rare in crushes from fracture dislocations, less rare in bullet wounds and common in transverse myelitis. No method of treatment should be adopted which leads to the death of a single recoverable case, for the reason that it avoids the retention of

suprapubic fistula in cases which are going to remain complete even if such retention is a real disadvantage

Whatever method is adopted hexamine should be given when possible before the treatment is started and continued during it so that formaldehyde is present in the urine from the beginning. Hexamine is probably useless if the urine is already infected and certainly if a urea splitting organism is present in it. When possible the amount given should be determined by applying Rimini's test to the urine as 30 gr. daily may not produce formaldehyde in the urine of some patients and may produce a chemical cystitis in others.

After a transverse lesion of the cord the bladder cannot be left alone because it becomes disorganized to a greater or lesser extent by overstretching and also its size adds to the interference in the function of the other abdominal organs. To avoid this and any possibility of artificial infection some surgeons with experience of gunshot wounds in the last war spoke in favour of emptying or partially emptying the bladder periodically by manual pressure on the abdomen. It seems probable that the only cases in which this method met with any success were those of cauda equina lesions since urethral resistance is too great to permit it when the nuclei of the pudic nerves and their peripheral connections are intact. A cauda equina lesion can be differentiated from a transverse lesion of the cord by the absence of the bulbocavernosus reflex even immediately after the injury. It is quite possible that cauda equina lesions can well be dealt with in the acute stages by manual expression and no harm is likely to arise from trying this method unless so much time is spent that damage to the bladder from prolonged over distension is allowed to occur.

Tying in a catheter is a most fatal way of treating the condition because the bladder is certain to get infected and a catheter is a very imperfect drain. Various complicated apparatuses have been devised to attach to the end of the catheter with the object of preventing infection in some cases they may delay the latter but in others gangrene of the bladder occurs. In war when in many cases there is necessarily no attention for long periods tying in a catheter is probably the worst form of treatment and quite possibly worse than none at all.

Intermittent catheterization has been successful in some cases over very many years but usually only in those whose circumstances are such that the same skilled person can always pass the catheter. It is therefore quite inapplicable to war and usually to hospital patients.

Suprapubic cystostomy performed before the bladder has become damaged is likely to save the most patients because although the bladder is certain to become infected with the patient's own skin and fecal organisms the efficient drainage given makes this of less consequence. In war this method has the great advantage that it requires less attention afterwards. A Winsbury White tube or some other form of self retaining tube should be put into the bladder and stitched to the skin. The tube should be changed every eight or ten days and the bladder washed through the tube which has been freshly introduced each time the change is made. If more frequent irrigation is required this should be done through a catheter passed per urethram for the purpose and not through the stale suprapubic tube since the latter procedure is likely to wash phosphates off the tube into the bladder and these may lead to the formation of stones. If the patient is travelling a Mohr's clip is put on the tube and periodically released and if in bed the tube is connected by glass and rubber tubing to a boiled receptacle. If a plaster has to be applied to the pelvis for orthopaedic reasons it is important that the cystostomy should be made as high as possible.

Partly from urinary sepsis and partly from fixation in one position patients with lesions of the spinal cord affecting micturition are peculiarly liable to develop stones in the kidneys. This liability is to some extent diminished by periodically altering the position of the patient whenever orthopaedic considerations permit it. The stones are sometimes discovered when they are still small enough to pass they should then be encouraged to do so by frequently altering the patient's position when possible and by giving large amounts of water. Renal colics frequently arise particularly when the patients first get up and should be treated with morphia. If a renal colic is accompanied by fever and rigors lasting more than a few hours the case requires immediate treatment by ureteric catheterization if possible or by removal of the stone from the ureter by operation if not since obstruction combined with sepsis results in a rapidly progressing pyelonephritis. On account of their rapid recurrence stones in the kidney itself are seldom worth operating upon in such cases unless the lesion of the cord has recovered to a large extent since their formation.

**CHRONIC STAGE**—When the bladder condition has become chronic or has never been acute suprapubic cystostomy is usually only advisable if a septic complication has become severe enough to threaten the patient's life without it. If a prostatic abscess has been opened through the perineum of a patient with tabes the fistula is likely to remain open unless a suprapubic cystostomy is established.

The commonest symptom which calls for treatment is incontinence. This can be dealt with by wearing a urinal or by intermittent catheterization. The latter is ineffective unless the volume of residual is large. If the patient's circumstances are such that he can arrange for catheterization to be properly carried out this is better than wearing a urinal when the volume of residual is large. He is not then subjected to the risk of developing sores from the urinal. In most cases it is evident that intermittent catheterization will not be properly carried out and then the patient should wear a urinal which is less bother to a more or less helpless patient than a suprapubic cystostomy. Wearing a urinal does not relieve the back pressure effect on the kidneys of large volumes of residual urine but unless urinary infection is severe this progresses much more slowly in nervous diseases than in mechanical obstructions.

The other condition commonly requiring treatment is recurrent exacerbations of cystitis. This commonly improves temporarily with irrigation of the bladder unless secondary stones are present.

### ATONY OF THE BLADDER

Atony of the bladder is a term used to express the idea that there is a failure of the bladder to empty itself in the absence of obstruction of a disease of the bladder wall which mechanically prevents its contraction such as fibrosis following pelvic cellulitis and of lesions of the central nervous system or peripheral nerves of the bladder. The effects of mechanical causes of obstruction have at various times been partly or wholly attributed to atony and the effects of nervous diseases probably not less so. At the present time cases to which the term can be applied are so rare that it is possible they may all be due to obstructive causes or nervous diseases which have been overlooked.

The residual urine of senile enlargement of the prostate was at one time believed to be partly due to atony and this belief was only dispelled when it

became apparent that in a large majority of cases the residual urine became insignificant after prostatectomy. In a small proportion of cases this does not occur a few of these can be shown to have a nervous disease capable of producing residual urine but most cannot. Before attributing this last group of cases to atony it must be remembered that what appears to be a very slight obstruction may be adequate for the purpose for instance if the superior opening of the prostatic cavity takes an 18 F catheter but nothing larger. Cases with residual urine after prostatectomy which had not developed and do not develop signs of nervous disease can therefore only be properly attributed to atony after they have been found to fulfil conditions which in fact they seldom have fulfilled.

Some obstructive conditions have been mistaken for atony primarily. Senile enlargement of the prostate occasionally produces large volumes of residual urine leading to overflow incontinence when no alteration can be felt on rectal examination but in such cases there are well marked signs of a posterior intravesical projection on cystoscopy.

Carcinoma of the prostate is occasionally mistaken for atony when the rectal signs are slight and overlooked.

At the present time most of the cases wrongly attributed to atony are those of Marion's bladder neck disease a term which probably includes more than one pathological condition its old descriptive name of *prostatism sans prostate* shows well what was formerly thought about it. In it there are no alterations in the physical signs felt on rectal examination and the diagnosis depends on cystoscopic signs. On cystoscopy it is seen that the posterior edge of the internal meatus instead of curving off into the urethra from the level of the trigone is sharp and slightly raised above the level of the trigone. In most cases the bladder is markedly trabeculated. On cystostomy the internal meatus can be felt to be more firmly closed than usual and the bladder is greatly thickened. The condition is frequently associated with vesical diverticula.

A small proportion of cases of urethral stricture develop large volumes of residual urine very slowly and in consequence the signs of renal failure develop slowly. They occur in cases of stricture of long standing whose treatment has been irregular but they by no means always occur in cases whose calibre is narrow at the time that the residual urine is discovered. These cases were regarded by Marion as the condition which now bears his name and it may be that some of them are such. At least a proportion however fail to respond to operations on the posterior urethra and show extensive atrophic changes in the bladder muscle on histological examination.

In infants large volumes of residual urine in association with dilated ureters and renal pelvis occasionally occur the condition occurs in both sexes and the patients usually die before they grow up. These cases have been attributed to atony but it is more probable that they are due to obstruction because the bladder is thickened and because in some cases measures taken to destroy the obstruction have been successful.

Cases occasionally occur in which all these conditions are apparently absent since appropriate measures for the relief of obstruction have failed and no physical signs of nervous disease can be found and these do not arise at least for many years. These may really be cases of atony but as there is no positive way of making the diagnosis the possibility that this has failed should be borne in mind in each case. The diagnosis of atony should not be made while there is any possibility of a curable obstructive cause being present unless surgical means to relieve obstruction have been tried and failed in a patient.

## CHAPTER XXVIII

### OPERATIONS ON THE BLADDER

#### OPERATIONS TO RELIEVE RETENTION OF URINE

THE relief of retention of urine will usually be achieved by catheterization (see p 447) and only when this fails will any other measures be taken. These may be a suprapubic puncture or an open cystostomy.

1 **Suprapubic puncture**—This small operation is practised when retention cannot be relieved by catheterization—almost invariably a preferable measure.

It may be performed (a) By a spinal needle which is introduced just above the pubis in a vertical direction. On entering the bladder fluid will be tapped and a rubber tube can be attached to carry it away. When the bladder is evacuated the needle is withdrawn. Such aspiration has on occasion been repeated.

(b) By a trocar and cannula of the usual type. In view of its large size the skin and track should be rendered insensitive with novocain and it is well to make a nick with a scalpel in the skin through which the instrument will pass. The entry into the bladder can be judged by a sense of diminished resistance and the trocar is then withdrawn a finger temporarily stopping the outlet of the cannula.

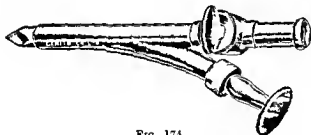


FIG 174  
Kidd's trocar and cannula

A catheter of the largest size which will pass comfortably is introduced into the bladder and is steadied in position whilst the cannula is removed.

Neither of these methods is recommended. If the bladder contents are unsterile the track through which the instrument must be withdrawn is necessarily contaminated. Leakage from the bladder is also quite likely to take place. Extravasation into and suppuration within the space of Retzius follow either of these accidents. There is nothing permanent or reliable about either procedure.

(c) Kidd's bladder trocar and cannula is shown in Fig 174. It is designed for the introduction of a self-retaining catheter which can be left *in situ* for an indefinite period. Its large size demands good local anaesthesia and the introduction has to be somewhat forceful. When the instrument is in position the stop cock on the straight tube is closed and the curved trocar is then withdrawn into the side limb. The instrument is now steadied by an assistant and an expanding-ended catheter (Figs 175 and 176) mounted on an introducer is passed as far as the stop cock which is then opened. The catheter moves on into the bladder and is left there the cannula being eased out of the wound. Finally the introducer which hitherto has kept the rubber catheter on the stretch is withdrawn. The spreading end retains this in the bladder and

gentle traction on the catheter itself brings it into the summit of the viscus. Once the catheter has entered the bladder close attention is paid to preventing the sudden release of bladder pressure which of course, is known to be injurious. Immediately the introducer is removed the tube is spigoted and the urine is



FIG 175  
Malecot catheter



FIG 176  
de Pezzer tube

withdrawn at a regulated pace. A stitch to the skin may with advantage be employed to keep the catheter in position, as sometimes a patient will himself pull it out.

This operation, though preferable to the previously mentioned forms of bladder puncture, has its defects. It assumes that the peritoneum has risen during the bladder distension and that an uncovered area exists through which it is safe to puncture. This is not always true. I have on several occasions seen the peritoneum anchored down to the pubis and forming a pouch in front of the distended bladder, and the pouch may even contain small gut. My own practice is therefore to open the bladder through a 2-in. incision in the linea alba under direct vision, and thus I regard as a safer method.

2 Cystostomy—The bladder is approached through a small median vertical incision  $1\frac{1}{2}$  to 2 in. in length. The recti having been separated and the fascia transversalis having been sponged aside, the distended viscus comes into view.

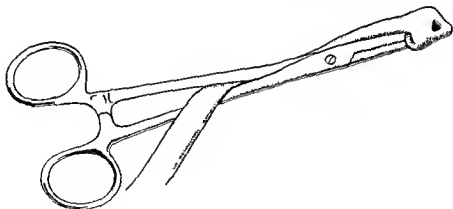


FIG 177  
Method of keeping a de Pezzer or Malecot catheter on the stretch during introduction (suprapubic)

It is steadied with tenacula and a No. 32 expanding ended catheter is held in readiness. This catheter is kept on the stretch by a pair of 7 in. artery forceps, the beak occupying the tip of the catheter and the tube being retained in extension by being nipped between the shaft portions of the forceps (Fig. 177). The outer end of the catheter is spigoted. An incision in the bladder wall is made by means of a scalpel and the catheter is slipped through it, the artery

forceps being immediately unclipped and removed so that the tube expands in the wound. A stitch in the bladder wall above and below the catheter ensures a watertight joint and one of these stitches is used to fix the bladder to the undersurface of the abdominal wall. The expansion of the catheter end occupies a position just below the bladder incision. In cases of urinary retention the flow of fluid from the bladder is regulated by one of several means, the author's preference being to plunge a hypodermic needle through the catheter wall and let the urine drip slowly away.

### EXPOSURE OF THE BLADDER

**Anæsthesia**—The ideal anæsthetic for vesical work is a spinal and heavy nupercaine is employed routinely in the author's cases. Premedication with omnipon ( $\frac{1}{2}$  gr) and scopolamine ( $\frac{1}{100}$  gr) is customarily given one hour before the operation but reduced doses of these drugs are used in the very aged or

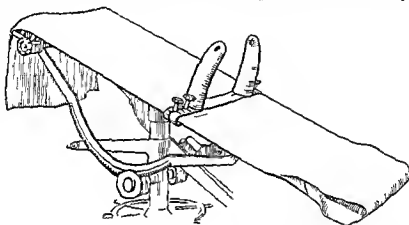


FIG. 178

Anti or a pelvis grip. Grasp the trunk immediately above the iliac crests ensuring stability and avoiding the danger of drag on the brachial plexus if shoulder rests are employed.

feeble. In robust subjects *secoinal* (3 gr) may also be administered with advantage. The resulting relaxation is excellent and offers relative freedom from pulmonary complications and vomiting.

Inhalation anæsthesia is generally not desirable especially in the old but *local anæsthesia* has an important field of application particularly when doing cystostomies on patients *in extremis*. It may be used with negligible shock in subjects who would otherwise be quite unsuitable for any surgical procedure. On several occasions I have done major operations such as the removal of a large papilloma from the bladder with local anæsthesia and have seen a prostatectomy performed under it though I have not myself attempted this.

In placing the patient on the table provision should be made for the Trendelenburg position as most bladder operations call for it. For this purpose fixation by the ankles and with the shoulder rests is satisfactory but a better way which avoids the danger of drag on the brachial plexus is the pelvic grip (Fig. 178) originally introduced by the writer in 1921, to obtain the best position for external urethrotomies and other perineal operations.

**Preparation of the bladder**—As soon as the anæsthetic has become effective the bladder preparation is undertaken by a gloved assistant who is not as

yet fully dressed for the operation. Prior to introduction of a catheter for this purpose the prepuce should be withdrawn and its undersurface, together with the glans penis, should be scrupulously cleaned. This very important preliminary is often carried out perfunctorily and the resulting soiling of the

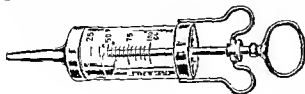


FIG 179  
Bladder syringe

surgeon's gloves during the operation is most regrettable. By means of a catheter the viscus is now emptied, and if cystitis is present a few washes are given with a bladder syringe (Fig 179). The next step varies with the nature of the operation. If it takes the form of a partial

cystectomy or other operation in which the bladder must be extensively mobilized the viscus is left empty, as this gives the greatest amount of room for perivesical stripping and manipulation. But for the more common intravesical procedures in which the bladder is straightway opened the organ should be distended and for this purpose either air or lotion may be used. Each has its own merits and drawbacks. The disadvantage of air is that in some recorded instances the air has passed up a patent ureter to the kidney and an air embolus has resulted. Though probably not a common accident the possibility of this cannot be entirely excluded. The objection to a fluid medium is that it flows out as soon as the bladder is incised and may infect the prevesical space, especially if, as is so often the case, bladder sepsis is present. But a combination of lotion and air gives the ideal method for if the trigone and ureteric orifices are covered with a couple of ounces of fluid this will preclude the entry of air by the ureter, and the bladder can now be safely filled with air up to the desired extent—say the equivalent of a further 6 oz. of fluid. By this means the danger of air embolism is avoided and the spilling of infected

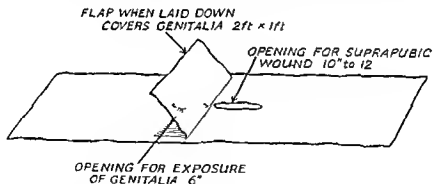


FIG 180  
Diagram of sheet employed during bladder operations on the male

lotion into the prevesical space is also forestalled. The catheter is now removed and the penis is again cleaned with spirit as is also the scrotum, and the external genitalia are placed on a sterile towel so that no further attention to these parts is required. The assistant who has carried out this work now retires to change his gloves and to complete his personal toilet. The operating sheet (Fig 180) has a double opening the upper and larger one being for the suprapubic area. The lower and smaller one has an overlying flap by which the penis and scrotum are covered till their exposure is necessary.



The suprapubic approach to the bladder has nowadays almost completely displaced the centuries old perineal route. A few surgeons use a transverse skin incision but the one employed by the writer and by the majority of operators is a median vertical one. Its length varies according to its purpose. Thus if it is intended to make a simple drainage (p. 188) the smallest incision giving adequate operating room is the best and  $1\frac{1}{2}$  in. in a thin subject or 2 in. in a stout one will prove adequate.

For all other operations an incision reaching from the pubis upwards for 5 or 6 in. is required. Subcutaneous vessels give but little trouble though in odd one or two may need ligature at the lower end of the wound. The deeper approach through the muscular layer may again be a transverse or a vertical one. Some use the former keeping it about an inch above the pubis and notching the edges of the recti to gain adequate space. It generally heals well but the writer regards the vertical mid line incision of the deeper structures as giving freer access. Such an incision is carried right down to the symphysis pubis in order to get the maximum room low down where it is most needed. The small pyramidalis muscle of one or other side appears in the lowest section of the wound and it is well to follow its outer border as otherwise its upper end will be left unattached. As soon as the recti are separated a self retaining retractor is introduced—the Gossett retractor (Fig. 181) serves admirably—and the head of the table is lowered to a fairly steep Trendelenburg position. Crossing the wound in its central section will now be seen the semilunar fold of Douglas. Extra room will be gained by dividing it and also the lowest inch or so of the posterior rectus sheath of which it constitutes the inferior margin.

Lying in the lower part of the wound the bladder is still hidden from view by the thin fatty transversalis fascia containing a variable number of vessels sometimes of quite large size. This fascia must now be displaced by blunt dissection with a gauze covered finger when the outer longitudinal coat of bladder muscle will come into view (Fig. 181 (1)). As with the two superficial layers the bladder itself may be incised in a vertical or transverse direction. The writer's technique varies here. When he desires a particularly free exposure of the bladder interior as for instance in dealing with a large pyeloma a vertical incision probably gives the best access. It is thought however that a transverse incision gives superior healing. This is because the place if any where healing fails is the inferior part of a vertical opening which lies behind the pubic bone. A transverse incision avoids this. Whichever incision is proposed the surgeon first computes the point where the reflection of the peritoneum takes place a point which may be plainly marked by an evident urachus or which may be difficult to define precisely. A transverse incision would run its course about half an inch below this reflection a vertical one extends right up to it. Stay sutures are now inserted on either margin of the proposed line of incision. A cone of bladder is lifted up by means of these stays and some gauze is lightly packed into the wound around this cone (Fig. 181).

An endothermy needle is used to open the bladder this instrument giving rise to less hemorrhage than a scalpel or scissors. The whole extent of the proposed incision is traced on the bladder wall with the needle but it is the apex of the cone which is opened in the first instance and as the upper part of the viscus contains air no spilling of lotion occurs. The opening may now be extended as far as desired by gentle digital traction the deeper layers of the vesical wall yielding easily. A nozzle connected to a pump next removes the lotion covering the bladder base (Fig. 181 (4)). The older method of allowing bladder contents to flow away through a dish with a hole in its base

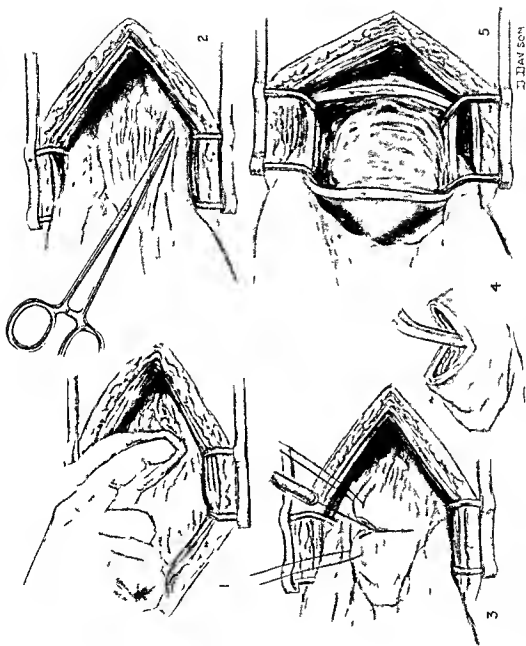


FIG 181

Stages in the opening of a bladder. 1 Retal incision complete. 2 Protecting perivesical spaces by tucking gauze in. 3 Cone of bladder raised by stay sutures being opened transversely by endothermy. 4 Final in vesical sump being sucked out through glass nozzle. 5 Vesical incision extended. retractor transferred to bladder.

is obsolete and was very objectionable because the fluid generally unsterile first of all filled the prevesical space and inevitably led to sepsis. An open ended glass tube bent at a right angle and with a 7 in intravesical limb is more convenient for bladder work than the metal tubes with multiple orifices supplied by instrument makers. Through out many operations the pump is in constant demand to clear away blood urine or pus charred portions of papilloma or other debris which may require removal. The pump employed must be sufficiently powerful to act promptly and decisively. An inefficient pump wastes much time and causes much irritation. The self retaining retractor is now removed from the parietal wound and may be placed in the bladder itself (Fig 181 (5)). Alternatively one of the more specialized bladder retractors may be preferred and of these the Clifford Morson or Swift Joly patterns (Figs 182 and 183) can be recommended.

The bladder now lies displayed before the surgeon together with the special objective of his search. The subsequent stages vary with the purpose of the operation and will be described in the appropriate sections.

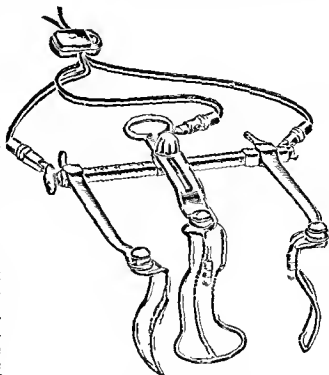


FIG 182

Clifford Morson's bladder retractor

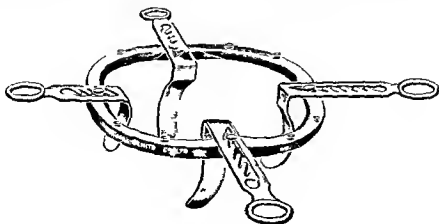


FIG 183

Swift Joly bladder retractor

## SUCTION DRAINAGE

For many years the writer has been accustomed to keep the bladder empty by suction. This entails removal of the fluids from the bladder sump as soon as they enter. A suitable vesical tube and a pump are required. The apparatus shown in Figs 184 and 189 has an external tube of the well known Freyer type. At its outer end a metal clip (Stedman's) holds a catheter in such a position that its tip lies  $\frac{1}{2}$  in. above the lower end of the outer tube, so that when suction is applied to the extravesimal end of the catheter it is impossible for the bladder mucosa to suffer injury by getting drawn into the catheter eye. The output of urine (2 to 4 oz. per hour) will obviously not keep the catheter filled and an inlet for air must be provided so that negative intra-vesical pressure may be prevented. In this apparatus the air inlet is supplied by the outer tube.

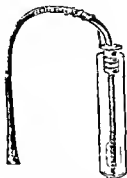


FIG 189  
Stedman tube

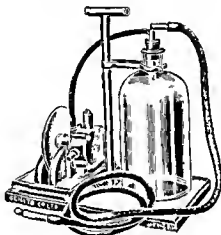


FIG 190  
Electric pump

The suction may be provided by a pump actuated by water by electricity or by other means. In my wards at the hospital certain beds are connected up to a water pump situated in an adjoining room (linen room or ward kitchen). There is no wastage of water as this, not being contaminated, returns to the general hospital system.

The little electric pump seen in Fig 190 is an excellent device where water is not available and is used by me in private. It is dependable, almost noiseless and gives enough power. It is placed on a small stool near the bedside and at a level slightly below that of the bed so that gravity may aid instead of hinder the flow of fluids.

If neither of these methods is available a Higginson syringe may be employed. It calls for attention at ten minute intervals, but the extra trouble is fully rewarded by the wound's favourable progress and the comfort of the patient.

Suction drainage cannot be satisfactorily cared for under the bedclothes. I therefore recommend that a division be made in the patient's coverings, the lower set extending up to a point just above the pubis, and the upper down to just below the umbilicus. The wound remains uncovered, and is protected from the bedclothes by sterile towels. Two small pillows are placed against

the patient's hips for purposes of warmth and a layer of cotton wool covers the iliac fossæ to within 3 in. of the wound.

The suction continues uninterruptedly for about sixty hours after which both it and the prevesical drain may be removed. The exclusion of tissue spaces and the healing of the wound in the parietes has by now progressed far enough to make them capable of withstanding urinary contamination. After the removal of the tubes however catheter drainage is as a rule found capable of maintaining a dry wound. In the after care of partial cystectomies or other very major operations on the bladder it may be considered desirable to continue suction for a longer time so as to permit more advanced healing to take place and there is little or no disadvantage in so doing. Healthy wound edges fall together almost immediately the tube is withdrawn and they quickly seal across even after this more prolonged drainage.

From the fourth day onwards the bladder is gently irrigated by means of a syringe (Fig. 179) fitted to the inflying catheter. It is important that the viscus should not be over filled and no more than 1 or 2 oz. must be introduced at one time. The lotion is allowed to flow back and the process is repeated several times. Lavage may be carried out two or more times daily according to the needs of the individual case. The thing which counts is the mechanical washing the choice of solutions being less important. Simple fluids are generally to be preferred to stronger antiseptics. Sterile water, boracic (sat. sol.) and potassium permanganate (1 in 8 000 to 1 in 6 000) are generally useful.

The catheter is retained throughout the healing of the wound. When during bladder lavage the wound has proved watertight for forty-eight hours the catheter may be removed. In the case however of extensive operations on the bladder and especially on its base a longer period should be permitted to elapse before withdrawal of the catheter so that healing and epithelialization may be well advanced.

J. B. MACALPINE

## CHAPTER XXIX

### SURGICAL ANATOMY OF THE MALE URETHRA

**T**HE length of the urethra varies in different people and at different times in the same urethra because the parts are very extensible. From post mortem records the average figures are —

Total length	8½ in
Prostatic urethra	1½ "
Membranous urethra	4 "
Pars cavernosa	6½ "

If measured during life by a graduated catheter the average length is 7½ in.

The diameter of the urethra after death is not so important as its degree of dilatability during life. Post-mortem figures, estimated by wax casts, are —

Near the meatus	⅜ in
At the bulb	⅙ "
At the membranous urethra	⅜ "
At the prostatic urethra	⅙ "
At the neck of the bladder	⅜ "

The diameter of the external meatus varies greatly, and in many cases is much less than the above figure. Also the external meatus is the least dilatable part of the whole urethra.

**Prostatic urethra**—In later life the length of the prostatic urethra varies depending upon the degree of prostatic hypertrophy. Its diameter is greatest about the middle, which is very dilatable. On the posterior wall is a median ridge called the *crista urethrae*, at the distal end of which is the *verumontanum*. The prostatic ducts open into the urethra along the sides of the *crista*. Unless inflamed they are not visible. The *verumontanum* contains erectile tissue, and varies in size. On its summit opens a blind sinus, the *sinus pocularis*, which represents the fused ends of the Mullerian ducts from which the uterus and vagina of the female are developed. The common ejaculatory ducts open on either side of the sinus and in some cases in the sinus. Because of its erectile tissue the *verumontanum* prevents the regurgitation of semen into the bladder during coitus. The *verumontanum* is generally left intact after suprapubic removal of the prostate.

**Membranous urethra**—This lies between the two layers of the triangular ligament, and is surrounded by muscle, the external sphincter.

**Pars cavernosa**—This varies much in length during life because of erections. The ducts of Cowper's glands, which lie between the layers of the triangular ligament, open into the floor of the urethra near the bulb. The glands of the *pars cavernosa* chiefly lie on either side of the mid-line on the roof. They are known as the glands of *Littre*, and the ducts open towards the meatus. The terminal dilated part of the urethra is called the *fossa navicularis*. There are two large sinuses here called the *lacunæ magna*. Because the ducts and sinuses open in the roof towards the meatus, when introducing a bougie or

catheter the tip of the instrument should be kept in contact with the floor of the urethra

The urethra is surrounded by many yellow elastic fibres and except in the prostatic urethra the mucous membrane in the resting condition is thrown into folds and is rugose. This is important in the causation of stricture because if inflammation is present surfaces in contact adhere and unite.

The cellular structure of the mucous membrane of the urethra is transitional celled in the prostatic urethra, columnar celled in the membranous urethra and pars cavernosa squamous celled in the fossa navicularis.

**Fasciae**—These are important because they influence the spread of urine in cases of extravasation.

The deep perineal fascia or triangular ligament consists of two layers of firm fibrous tissue which extends between the two rami of the pubes and the ascending rami of the ischium. They are intimately related to the periosteum and are attached one to the posterior surface and one to the anterior surface of the pubic arch. In front they unite and intermingle with the fibres of the subpubic ligament. The compressor muscle passes between the two layers. The lower border of the anterior layer is continued as Colles's fascia over the scrotum and unites with Scarpa's fascia where it is fixed to the thigh. The flow of extravasated urine if the membranous urethra is ruptured is thus directed into the scrotum and upwards over the abdomen. The urethra perforates the perineal fascia about an inch below the symphysis pubis and this being the most fixed part of the urethra is the most liable to damage by external trauma.

Between the two layers of the triangular ligament pass the nerves and arteries supplying the penis and the compressor muscles. Incontinence after endoscopic resection of the prostate may therefore be due not to resection of

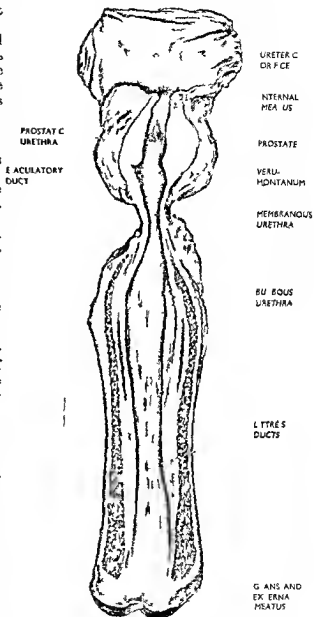


FIG 191

part of the external sphincter as many suppose but to heat damage to the nerves and fibrosis of the muscle. Many of these cases recover in time and require no specific treatment.

**Muscles**—Involuntary muscle is present along the whole course of the urethra but is most manifest in the region of the prostate. It is less evident in the membranous urethra and very sparse in the pars cavernosa. The corpus spongiosum is also surrounded by a layer of involuntary muscle and thus affects the urethra. These muscles are responsible for the powerful spasmodic contractions which occur during ejaculation and also for spasmodic stricture.

The chief voluntary muscles acting on the urethra are the levatores ani, the compressor urethræ and the bulbocavernosus.

The anterior fibres of the levatores ani pass downwards along the sides of the prostate, are inserted into the central point of the perineum and are designated the levatores prostatae.

The compressor urethræ is enclosed between the two layers of the triangular ligament. It arises from the pubic ramus and the fibres pass inwards to encircle the urethra. Those fibres in immediate relationship to the urethra form a tubular sheath with no bony attachment.

The bulbocavernosus arises from the central point of the perineum and its fibres pass outwards and forwards and are inserted into the triangular ligament, the membrane covering the corpus spongiosum and into the fascia covering the dorsum of the penis. Apart from arresting the venous return when the penis is in erection, those fibres of the muscle surrounding the bulb have a direct compressive action on the urethra.

**Arteries**—The blood supply of the urethra is derived from the internal pudendal artery while it lies between the two layers of the triangular ligament. One branch goes to the bulb of the urethra and to Cowper's gland. Another branch is given off distal to this and entering the corpus spongiosum is continued forward to the glans penis.

**Nerves**—The urethra is innervated by the pudendal nerve which arises from the second, third and fourth sacral nerves. The pudendal nerve traverses the space between the two layers of the triangular ligament. Branches are given off to the muscles of the urethra and to the mucous membrane.

**Lymphatics**—The lymphatics of the cavernous urethra drain into the inguinal glands and the external iliac glands.

The lymphatics of the membranous urethra and of the prostatic urethra also drain into these glands but chiefly into the hypogastric glands.

### PHYSIOLOGY

The function of the urethra is twofold. First it is a channel for the evacuation of urine from the bladder and second it is a channel for the transmission of semen into the vagina.

At rest the urethra is not a channel but a closed tube. Complete relaxation of its musculature is necessary for the detrusor of the bladder to function adequately. The voluntary muscles in relation to the urethra are sphincteric when in action. The synonyms for the bulbocavernosus viz. ejaculatory urinae and accelerator urinae are misnomers for during micturition the bulbocavernosus relaxes and it is also evident from its origin and insertions that during contraction it must tend to occlude the urethra. Relaxation of the involuntary muscle of the prostatic urethra must also occur for it is intimately related to the bladder musculature and helps to form the internal sphincter.



The urethra as a separate urinary channel ceases to exist at the termination of the membranous urethra after which it becomes urogenital. The urethral stream can be stopped by an effort of will the seminal emission cannot.

The emission of seminal fluid is a complicated act. The neck of the bladder and the prostatic urethra must be closed while the urethra distal to the verumontanum is subjected to alternating relaxations and powerful contractions of its musculature. The whole process is a reflex one and uncontrolled by the will, although some of the muscles involved are voluntary and usually controlled by the will.

The verumontanum contains erectile tissue and not only prevents the backward passage of seminal fluid but because of the groove on either side directs the flow forward. When the fluid has accumulated in the bulb of the urethra the final contraction of all the muscles of the urethra projects the fluid forwards, backward regurgitation being prevented by the compressor urethræ. The involuntary muscle is intimately related to the genital act.

F. MCG LOUGHVANE

## CHAPTER XXX

### EXAMINATION OF THE MALE URETHRA

**A** PATIENT with urethral symptoms should be examined thoroughly and systematically and no prudish restraint should prevent complete investigation

**History**—The patient should be encouraged to describe his symptoms in detail however trivial they may appear. Sometimes these may be merely a fear complex inability to micturate in front of others. If thorough investigation is negative in regard to organic disease and fails to reassure psychiatry is indicated. The patient should always be asked whether he has had syphilis or gonorrhœa.

**Pain** at the beginning of micturition generally means that there is some obstruction to the onward flow of urine *e.g.* a plug of mucus mucopus blood clot small calculus or stricture. The pain continues until the obstruction is overcome. If pain is present throughout the act of micturition it may be due to some irritating constituent in the urine or to a too great concentration of a normal urine. A complete urinalysis therefore should never be omitted. Pain may also be due to an inflamed urethra or a narrow meatus. Pain at the end of micturition is due to vesical calculus or inflammation of the bladder neck. The passing of blood and pus may be initial terminal or durational depending on whether the lesion is in the urethra at the vesical neck or in the bladder. If terminal it is due to a final muscular contraction of the vesico-urethral muscles.

**Frequency** of micturition may be due to renal or vesical as well as urethral lesions.

**Renal frequency** is a reflex and often the first indication of renal tuberculosis. It is unassociated with urethral pain or discomfort. Vesical frequency may be accompanied by hypogastric pain and terminal dysuria even strangury.

**Urethral frequency** may be accompanied by durational discomfort and a feeling of irritation may be experienced in the urethra after micturition has ceased. If cystitis or urethritis is marked the frequency will be unaccompanied by features suggestive of a differential diagnosis. Very often the patient merely complains of frequency and the type of pain or discomfort associated with it is only elicited on careful questioning. If frequency occurs only in the daytime and not at night no local lesion is responsible but some derangement of the nervous system providing that a vesical calculus or foreign body has been excluded because either of these may be mobile owing to the patient's movements and if in contact with the trigone will cause irritation and frequency.

**Inspection**—This will show the presence of deformity fistula or discharge. This list should always be submitted to microscopy.

**Palpation**—This may elicit pain or tenderness and the detection of induration calculus or foreign body.

**Urethroscopy**—The patient should be in the lithotomy position and the table slightly tilted so as to raise the pelvis. A Goring pattern of irrigating urethroscope is recommended. With this the bladder, the posterior and the



FIG 192  
Lower margin of internal  
sphincter



FIG 193  
Upper margin of internal  
sphincter

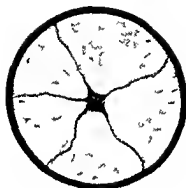


FIG 194  
Internal orifice inflow  
tap off

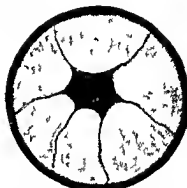


FIG 195  
Internal orifice inflow tap on  
showing alteration in mobile  
sphincter



FIG 196  
Prostatic lateral lobe hypertrophy



FIG 197  
Generalized prostatic hyper-  
trophy

#### Urethroscopic views

(from Urethroscopy Med cat Weid Longmire and Smith)

**Radiography**—This is helpful in many cases apart from the detection of calculi and foreign bodies. A urethrogram will reveal strictures, pouches, rupture and sinuses. In suspected trauma it is safer than investigation with catheter or bougie especially if lipiodol is used which has antiseptic properties. There are two methods of taking a urethrogram. Either the bladder is filled with an opaque medium and the urethrogram taken while the patient micturates, or the urethra is injected with the medium and the X-ray taken while the fluid is flowing. The latter is the better method for the fluid is under



FIG. 198  
Unequal lobular hypertrophy



FIG. 201  
Post resection fusion of lobes



FIGS. 199-200  
Post endoscopic resection views of internal urethral orifice

#### Urethroscopic Views

(From *Urethroscopy* Medical World, Townshend and Smith)

pressure and therefore abnormalities will be better delineated. The patient should be in a semi prone position while the X-ray is taken, so as to minimize the extent of bone the X-rays must penetrate. An antero posterior exposure is misleading because the curves of the urethra will obscure the picture of its continuity. In the absence of pathological lesions a urethrogram will show the urethra dilated with the opaque fluid to the junction of the membranous and bulbous urethra. The membranous and prostatic urethra are usually not delineated by a urethrogram except occasionally by a faint linear shadow. The opaque fluid in the bladder is generally visualized. If a stricture is present a constriction may be seen. General narrowing of the lumen of the urethra indicates periurethral fibrosis. Branching shadows indicate fistulae sinuses or false passages. If the orifices of the common ejaculatory ducts are patent

the seminal vesicles may be visualized    Odd shadows in the region of the prostatic urethra are either false passages or abscess cavities    Congenital malformations may also be revealed

**Bougies**—The acorn-tip bougie is sometimes useful in estimating the length of a stricture    An obstruction will be felt when the tip of the bougie engages the stricture and having been passed, then on withdrawal



FIG 202  
J C 14 years    normal urethra

the rim of the acorn will hitch against the stricture, and so its approximate length be ascertained

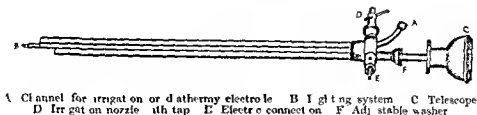
**Microscopy**—All urethral discharges should be examined, and in some cases cultures taken    Smears should also be taken after prostatic massage and stripping of the vesicles    Non-gonococcal organisms are very persistent, and treatment should be controlled and varied according to the microscopical report    Absence of spermatozoa in these smears is of no significance

#### URETHRAL SHOCK

Many patients the first time they are being instrumented suffer a mild degree of shock    This is chiefly noticed in the apprehensive type    Symptoms of shock begin to appear when tension is made on the suspensory ligament of the penis, the handle of the instrument depressed, the external sphincter dilated and the prostatic urethra negotiated    Usually pallor, sweat and

increased breathing are noticed and frequently full instrumentation has to be postponed. On a subsequent occasion there may be no shock and examination can be satisfactorily carried out. The phenomenon is a reflex one and not uncommonly occurs when a sphincter is first dilated. Dilatation of the cervix or the rectal sphincter in an infant may evoke a similar reaction. Even light cyan anesthesia does not abolish the reflex. Fortunately the degree of shock

Geisinger's Urethroscope



Seal

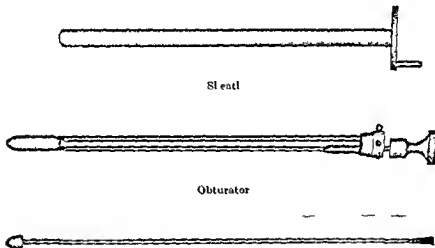


FIG. 903

produced although disconcerting at the time is not serious and readily responds to simple treatment *e.g.* sal volatile.

Rarely the shock may have fatal consequences. The face becomes pallid and sweaty, the pulse imperceptible, the pupils dilate and the patient after a gasp or two stops breathing. Cardiac massage and injection stimulation are seldom successful. To avoid such catastrophes the patient should be systematically examined first for most of the patients are elderly or suffer from some circulatory complaint. The operator should always have at hand appropriate restoratives *e.g.* brandy, sal volatile, pituitrin, ether and camphor. Fortunately fatal or severe cases of shock are extremely rare. An efficient local anesthetic which has been allowed enough time in which to act combined with gentle instrumentation will go far to prevent the onset of shock.

**URETHRAL FEVER (URINARY FEVER)**

This is sometimes called urethral or catheter fever. Most cases run a mild course, but often serious complications arise and occasionally there is a fatal termination. The onset of the fever very often has no relation to the severity of the urethral instrumentation. It is more likely to follow the first instrumentation than later ones. This may be due to the patient's developing more tolerance, or to greater care and production of less trauma on the operator's part (see p. 756).

F. McG. LOUGHNANE.

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## CHAPTER XXVI

### THE DEVELOPMENT AND CONGENITAL DEFORMITIES OF THE URETHRA

#### CONGENITAL DEFORMITIES OF THE URETHRA

**C**ONGENITAL deformities of the urethra are not, in the main, difficult of explanation. The development of this tube is not very complicated as are some of the processes which are involved of the parts above it, such as the bladder and the kidneys. The urethra of the female represents only the first or proximal part of this passage in the male and it is true to say that the female external urinary apparatus is, when compared with that of the male, in a condition which is known as hypospadias where the labia minora represent the unjoined parts of the more distal urethra of the male and the labia majora the scrotum.

The male urethra from the point of view of development is divided into three parts, just as it is anatomically. But the three parts do not correspond to each other, for whilst the generally recognized three parts of the male urethra are known as the first or prostatic portion, the second or membranous portion and the third or penile portion the first part is the only portion that roughly corresponds to the first part of the developmental portion. It is true that the second part corresponds to the membranous and most of the penile portions but the third part developmentally forms quite a small portion of the whole urethra, that which exists at the extreme distal part of the penis namely, the meatal portion of the urethra and as a rule this is certainly not longer than  $\frac{1}{2}$  in.

It will be well for us to look at the female external urinary parts, for they are exactly analogous to the corresponding male parts but there is one difficulty in the way of admitting an absolute analogy. If, in particular, the clitoris be examined it will be found to bear a close likeness to the male penis but on a diminutive scale. Thus there is a prepuce and a frænum, and a glandular part at the tip of this organ. Now if this does, in fact, correspond to the glans penis then the glans must be formed differently in the male, for it is connected with the corpus spongiosum, and this connection must therefore be a secondary union with a divorce from its original connections. Moreover in certain cases of epispadias the penis may be only developed so far as to show some growth of the genital eminence and no union be found between the two parts, but even such a penis bears a close resemblance to the normal organ with a dilated portion at its tip which may be looked upon as the original glans penis. However this may be it should be noted that the parts in the male do not exactly correspond to those in the female.

A very short description will now be given of the development of the male external parts which are in connection with urination. But it is necessary to say now that at one time the vagina in the female would appear to enter the urethra rather than vice versa. In the anterior part of the embryonic cloaca two protrusions appear, one on each side, these are known as the genital eminences. Eventually they grow forward and join with each other in the middle line to form the main mass of the penis, and in them erectile tissue is formed and the two parts of the original penis form the corpora cavernosa.



Below and behind the genital eminences there is developed bilaterally a ridge which likewise grows forward, these ridges come to blend with each other on their under side. Into this combination of growth forwards and blending of the ridges the first part of the urethra opens, and the urethral tube is thus prolonged forwards *pari passu* with the forward prolongation and blending of the genital ridges. This process is prolonged forwards to near the end of the penis, and the cloacal portion of the tube is met by a pit like formation which develops in the glans, and these two parts join evenly and symmetrically.

It may be noted here that the external meatus of the urethra which is thus formed is by no means a simple structure, for two raised flat plaques are developed on each side of the opening, which come into contact with each other, and are so arranged that the opening which they bound lies on a sagittal plane. It will be found that the upper and lower surfaces of the normal urethra come into contact with each other, and so the main part of the passage is compressed from above down, i.e. at right angles to the sagittal opening of the meatus. Thus a rifling action is induced and the urine is passed with greater force than it otherwise would be, and indeed we shall find later that the absence of this rifling action is a serious deficiency in cases of hypospadias.

As the genital ridges grow forwards to form the main part of the urethral passage, so erectile tissue is developed around the tube, and thus the corpus spongiosum is formed. But it may be repeated that the glans penis establishes a connection with this corpus spongiosum, which apparently it had not at an earlier stage. Some slight knowledge of this development is necessary in order that we may understand some of the deficiencies of the urethral passage, and it is upon the improper joining of the various parts that many of the congenital deformities of the urethra depend. But the junction which occurs posteriorly is a very different process from that which takes place between the second and third parts, for, behind, the genital ridges simply surround the opening of the first part whilst the junction of the second and third parts is a union between two totally different parts, viz. the meatus and the main part of the urethra, and it is in connection with this union, or its absence, that the main congenital deformities of the urethra occur.

The deformities that will be considered now are as follows: (1) hypospadias, (2) sacculus of the urethra, (3) congenital stricture of the urethra, (4) small meatus. The main points in connection with hypospadias will therefore now be considered.

**Hypospadias**—In this condition the distal opening of the urethra lies short of its usual termination, and the level at which the opening is found may vary from that of the perineum as far forwards as to be quite close to or indeed in the normal meatal region. Except in those cases in which the opening lies far back, the orifice of the incompletely developed urethra is nearly always small and circular, and shows none of the complicated appearance of the normal opening. Much more rarely it is transverse or it may be crescentic. Its edges are thin, translucent and membranous, very different from the sagittally disposed slit-like normal meatus. Moreover the plaques which border the opening normally contain lymphoid tissue and may be regarded almost as 'penile tonsils.' They are quite absent in all examples of hypospadias.

The normal meatus during the act of micturition is directed forwards and downwards and as has been mentioned has a rifling action, whilst the abnormal orifice is directed downwards. The penis is sometimes, not always, recurved and bent upon itself, and this is especially pronounced during erection of the penis. When the opening of the hypospadias is situated far forwards the normal meatus may be present, but it has made no connection with the poorly

developed tube of the urethra. The abnormal appearance of the orifice has been considered but this opening may be so small as to be hardly visible and it is not large enough to allow the passage of an instrument.

The opening of the hypospadias may be found anywhere between the original cloaca and the tip of the penis and any classification must follow on the levels at which the abnormal urethra opens. Some classification may be made as follows —

- |                            |                           |
|----------------------------|---------------------------|
| 1 Concealed hypospadias    | 5 Corporeal hypospadias   |
| 2 Glandular hypospadias    | 6 Penoscrotal hypospadias |
| 3 Coronal hypospadias      | 7 Scrotal hypospadias     |
| 4 Post coronal hypospadias | 8 Perineal hypospadias    |
| 9 Persistent cloaca        |                           |

**CONCEALED HYPOSPADIAS**—This is as a rule only discoverable when the meatus is opened widely. An opening will be found on the ventral aspect of the meatus but it is quite distinct. Such a condition may alter the shape of the meatus from being a simple sagittal slit to one which though in a similar plane is club or arrow shaped with the expanded end pointing downwards towards the frænum. It is as though the meatal part had just managed to meet the penile urethral part. In other words the lacuna magna opens by its floor into the main part of the urethra instead of having an opening directly backwards into the main part of the passage. Such a condition may not have any further associated deformity such as a hooded prepuce. This abnormality occurs in 14 per cent of the cases.

**GLANDULAR HYPOSPADIAS**—This is not at all an uncommon condition and as the normal meatus is present mistakes may be made as to the proper orifice through which an instrument may be passed. The opening of the true urethra may be very small. In such cases the abnormal orifice lies just behind the normal meatus and may lie in the upper end of the frænum i.e. the part near the meatus. A hooded prepuce may be present but not always. The condition occurs in 25 per cent of the cases.

**CORONAL HYPOSPADIAS**—A hooded prepuce is found with this condition and affords a useful piece of evidence that an abnormal opening is present though it may be very small. In such a case the frænum may be perforated by the abnormal opening but nearer the vascular base of this structure than in the case of the glandular hypospadias. The frænum may have a bifid appearance. Both this form and the second variety may be associated with a good deal of local sepsis as though urine had been collected under the edges of the frænum. It occurs in 14 per cent of the cases.

**POST CORONAL HYPOSPADIAS**—This and all the succeeding types except the persistent cloacal type are associated with the presence of a hooded prepuce. The orifice is situated behind but close to the corona glandis. It occurs in 24 per cent of the cases.

**CORPOREAL HYPOSPADIAS**—In this variety the opening is found on the undersurface of the body of the penis. Although recurvation of the penis is found in the preceding varieties yet it is always present in this variety. It occurs in only 2 per cent of the cases.

**PENOSCROTAL HYPOSPADIAS**—With the meatus situated at the base of the scrotum on its anterior aspect the deformity lends itself well to repair by the Bucknall operation (Fig. 206).

**SCROTAL HYPOSPADIAS**—In these cases the opening is situated in the ventral wall of the scrotum and may be retracted into the wall of the scrotum. It occurs in 2 per cent of the cases.

**PERINEAL HYPOSPADIAS**—This is relatively common but although the opening is in the perineum it must not be confused with the next type, for there is only one opening to be made out, and this is the opening of the abnormal urethra in other words some of the genital ridge portion of the urethra has been developed although it may be only a very small part This variety occurs in 15 per cent of the cases

**PERSISTENT CLOACA**—Cases of such a condition do occur and the parts may bear a close resemblance to those of the female, and as a pronounced condition the opening of the rectum in the cloaca must not be forgotten The author has not seen such a case, but from time to time such cases are noted especially if any operation that has been undertaken for the relief of the condition has been followed by apparently successful results

**TREATMENT OF HYPOSPADIAS AND THE REASONS FOR OPERATIVE MEASURES**—These questions must be considered from the aspect of the patient as well as from that of the race, depending as this does upon procreation and the continuance of descendants From these points of view the cases may be divided into those in which operations are called for by the individual condition and those in which continuity of the race is to be assured

*Cases of individual importance*—The small size of the orifice of a urethra affected with hypospadias may give rise to dysuria with its inevitable serious consequences and a considerable inferiority complex may result The hooded prepuce is a redundancy and is likely to be associated with sepsis This and the associated recurvation of the penis may draw undesirable attention, of the patient himself and his comrades, to the abnormal parts Moreover there may be much wetting of the clothes owing to the dysuria and to this recurvation and this may draw attention to the condition In fact some cases do not attend as early as they might do, and it is not until the attention of the parents has been drawn to the state of affairs by the undue attention of school comrades that surgical advice is at last sought In these cases the possibility of ascending nephritis must not be forgotten and insistence may be stressed upon the possible poor functioning powers of the kidneys

*Cases of racial importance*—When the opening is situated far back we have seen that it may lead to considerable difficulty in passing water properly, but from the point of view of procreation it is important to note that it may be impossible for semen to enter the vagina when a male is affected with any considerable degree of hypospadias It is interesting to note, however, that cases have occurred in the author's practice in which it would appear that neither entry of the penis into the vagina was necessary for the purposes of procreation, nor in every case of pregnancy has there been a vagina which could be entered Thus copulation may take place between the upper part of the thighs and pregnancy result, and the following cases have occurred in the author's own knowledge A man who had a partial amputation of the penis was presented by his wife with a fine child more than nine months after the operation Sir Alfred Fripp had a similar case A girl was brought to the writer because there was something wrong with the act of micturition and this defect had been noted by the schoolfellows of the patient It was found that the vagina could not be seen at all and the only opening that was visible was that of the urethra It was found that there was a continuous membrane developed in the perineum which completely obscured the vagina, but at an operation it was found that this was not an unduly developed hymen but a separate membrane, and when the latter was cut through there was seen a normal perforated hymen At the same time in the wards at Guy's Hospital there was a female patient who had an ectopic gestation, but no entry to a

vagina could be discovered. Naturally considered then this question opens up the possibility of neither penis nor vagina being necessary for procreation but practically they are so and in many of the cases of hypospadias procreation is impossible. The penis cannot enter the vagina owing first to the recurvation of the whole organ and if it can enter the vagina then the semen may be discharged before it can enter the vagina owing to the openings being situated too far back. In those cases in which there is a meatus which is well formed as well as the abnormal urethral orifice instrumentation may be very difficult and therefore dangerous for example in cases of elderly people with enlarged prostates. Under this heading may also be included the question of gonorrhoea occurring in those men who have hypospadias. The small opening and the recurved penis may prevent and hinder the exit of the discharge from the urethra and lead to the formation of gleet and stricture and if such occur then the patient is liable to become sterile.

**OPERATIVE MEASURES**—The above remarks indicate that there are many reasons for operative interference.

First the hooded prepuce calls for circumcision for it is a redundant tissue liable to dangerous sepsis. It also draws attention to the parts and may establish an inferiority complex. The operation in certain cases appears to diminish the recurvation. Secondly the question of operative interference may be considered now from the point of view of improving the local condition of the hypospadias. In the first place by restoring the parts to their normal condition the recurvation may be much lessened and the opening may be carried forwards so that micturition and insemination are possible. Before the general question of trying to cure the recurvation by the division of fibrous tissue it must be noted that much of the recurvation is not due so much to the formation of any fibrous tissue as to the shortening of the urethral passage

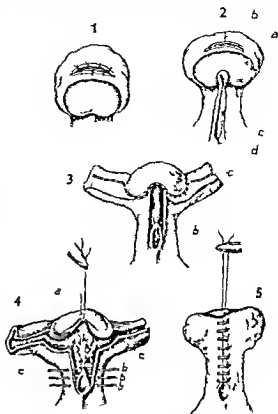


FIG. 11

The preliminary steps of Edmonds's operation on these result in undoing the curve in the penis. 1 Formation of the buttonhole in the prepuce. 2 The incision for the second stage of the operation (a) the buttonhole (b) incision through the prepuce (c) incision around the urethral groove (d) incision through flap of mucous membrane at opening of urethra. 3 The urethra detached (b) the shrunken and retracted urethral groove (c) incision through the mucosa of the prepuce on the left side around the glans and the right side around the mucosa of the prepuce on the right side. 4 Detachment of the flaps (a) guide steel through the flaps (b) first stitch (b') second stitch (b'') third stitch (c-c) points on the flaps which will form the most anterior part of the roof of the urethra. 5 Completion of the second stage. Ventral aspect of the penis. This is an excellent operation for straightening a penis which curves downwards. Subsequent steps can be carried out according to Bucknall's operation (see p. 386 and p. 334).

In any case the division of fibrous tissues is to be very seriously considered for its removal may lead to the formation of more, and the condition be rendered much worse than it was before an operation. Edmonds's operation (1900) is an excellent method of dealing with this problem, and this part of the procedure is depicted in Fig 204 (see also Fig 205)

A golden rule is to restore the parts to as normal a condition as possible, and it is surprising how the recurvation disappears after a successful operation for the relief of the hypospadias.

A word of warning may be uttered now with regard to the possible instrumentation for the purposes of dilating the abnormal orifice. Such dilatation should never be done hurriedly or forcefully, and when actual retention of urine is present the writer believes that suprapubic cystostomy is desirable rather than dilatation of the abnormal orifice under these circumstances.

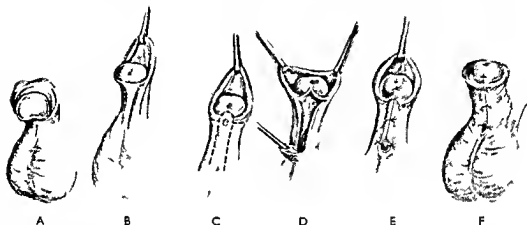


FIG 203

Operation for straightening curved penis in hypospadias. The curvature is due to the shortened incomplete urethra (Mr Winsbury White's case). A Shows the considerable ventral flexion of the penis and the hooded prepuce. B Tension on the prepuce obscures the external urinary meatus and brings into prominence the outline of the shortened urethra. C Dotted lines show the position of the meatus and the lines of the intended incision. D The meatus has retracted considerably after the incision. E Shows the new position of the meatus after suturing. F, There is now a complete absence of any curvature—compare with A.

The subsequent steps of the repair should follow the Bucknall principle—see Fig 206.

If dilatation is considered to be called for then it must be done either by the introduction of a very small laminaria tent, such as is used in midwifery, or if there is difficulty in due arrangements being made as to adequate urination, a small silver cannula may be introduced into the orifice and left *in situ* for a considerable time. This will lead to dilatation of the orifice and a permanent good result. But in many even apparently trifling cases of hypospadias some operation is called for of a cutting nature.

If there be a normal meatus present, as there often is advantage must be taken of its presence, and the new urethra should be so made that it enters into such a meatus. In one case, however, an abnormal opening which was situated upon the glans just behind the position of the normal meatus, and had led to considerable obstruction to the passage of urine, was treated by the writer as follows. Two circular incisions were made in the glans immediately round the orifice, one separated from the other by about one twelfth of an inch and a conical wedge shaped circular mass was removed of the depth

of about a quarter of an inch. The edges of the excised part were brought together with sutures and the wound healed by primary union. The operation widened out the opening and the result so far as the case was traced was very good.

This method of operating took account of only the widening of the orifice but more advanced operations entail the formation of a new tube. As before mentioned full advantage of any normal glandular meatus must be taken. Its normal structure cannot be disregarded and its very special nature must be noted in this connection. When the opening is situated on the body of the penis or on the scrotum Bucknall's operation may be performed but this has one great disadvantage namely the formation of hair after the age of puberty in any skin of the scrotum that has been used for the formation of the new urethra but the cases of the operation which were noted by the author were good as far as they were traced.

The writer has seen one case in whom a new urethra was constructed that caused much inconvenience to the patient owing to the production of hair within the tube and this hair caused no inconvenience until nearly the age of twenty one. Hair however does not occur in the mid line of the scrotum and not at all on the penis so that advantage can be taken of this absence by the surgeon's keeping as close to the mid line as possible so as to avoid the presence of potential hair. The danger of hairs occurring in the urethra can be obviated by first of all transplanting the prepuce on to the front of the scrotum with its mucous surface upwards (Fig 206). If however the operation is to be performed on an adult the hairs may be dealt with as a preliminary step as indicated in Fig 206. Bucknall's operation is performed as follows. It is most suitable for those openings that are placed at the junction of the penis and the scrotum. The steps of the operation may be left till later but an anæsthetic is essential and precautions must be taken to know the exact functioning power of the kidneys before the operation. Deformities of the upper and lower urinary tracts are occasionally associated together.

Before the operation potassium bromide 5 gr. three times a day or less in the case of children should be given for about two days and the bowels are to be opened. After the operation the patient should be allowed to get up as soon as is reasonably possible in order that his attention may be taken away from the parts concerned and in one case which occurred to the writer of a much more complicated condition namely ectopia vesicæ the child patient was walking about the ward and playing with other children in the first twenty-four hours after the operation. It may be necessary to administer opium in some form after the operation and Parker's rule given to the writer verbally is a very useful one. One minim of the tincture for each year of the child's age and 1 min added for the operation thus a boy of three would have 4 min of the tincture. The scrotum and the penis should be kept as high as possible after the operation almost on the surface of the abdomen. Bucknall's operation may now be described in particular. The patient is laid on the table in the lithotomy position and a large pad is placed under the buttocks. The necessary antiseptic precautions are taken. We shall suppose that the opening is situated at the junction of the penis and scrotum although this is not a common site. The question of a suprapubic cystostomy is very apt to be raised in this operation for although normal urine may be passed over a plastic wound with comparative impunity yet its passage may be associated with pain and the confidence of the patient in the surgeon be lost.

An incision in the long axis of the penis is made on each side of the mid line and as close to it as is possible and external to this primary incision a second

incision is made at about one eighth of an inch away from it. These incisions are continued backwards on the scrotum for an equal distance to that of the original incisions. The strip of skin between the incisions on each side is dissected up. Thus a linear raw area is left on the side of the mid line of the penis

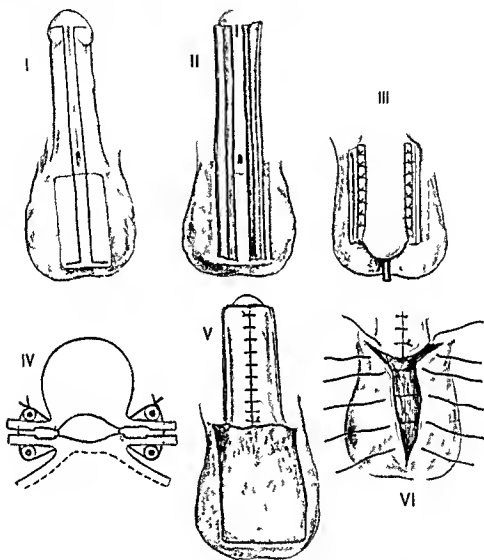


FIG 206

Bucknall's operation modified by transplanting prepuce on to front of scrotum as a first step. The cateter shown in III is removed at the end of the operation and a suprapubic cystostomy is established. (Mr Winsbury White's case)

and scrotum. Alternatively only one linear incision is made on each side of the mid line, with a short right angled incision at each extremity. This enables a skin flap to be dissected outwards (Fig 206). The anterior parts of the skin flaps and the raw area are brought into apposition with the posterior parts and the penis is thus laid on the scrotum. The inner edges of the opposed surfaces are then united with catgut sutures and they are tied but not with

too great tension. The raw surfaces are then united with catgut sutures passed Lembertwise. The outer edges are then united with salmon gut sutures. Plenty of sutures should be used but never should they be tied tightly for they easily cut through before the wound has healed. Fig 206 (iv) indicates an alternative method of suturing. In this operation the penis is anchored to the scrotum. After the parts have healed the portion of scrotum which is forming the wall of the new urethra is dissected up and its edges trimmed and if necessary its edges are secured with salmon gut sutures which are removed on the tenth day or thereabouts. In this operation then part of the scrotum is used for the formation of the new urethra.

The difficulty of adapting the edges of the scrotal part of the new urethra presented such difficulty to the writer that he has never followed this method although it marked a great advance in the operative procedures previously adopted.

The writer has been satisfied with comparatively simple methods and he here gives an account of what he has done in the way of a simpler operation than that of Bucknall. He does not pretend that it is original and in fact it is very old. Advantage is taken of the presence of any normal meatus that may be present and the edges are carefully guarded against possible damage. An incision is made on each side of the mid line about a quarter of an inch away from it and it extends as far forwards as to include the meatus and as far back as just behind the abnormal opening. At the posterior end of the incision it is allowed to converge towards the mid line and thus meet its fellow in the mid line behind the abnormal orifice. It may have been necessary to dilate the opening before the operation in accordance with principles already laid down. Another parallel incision is made on the other side of the mid line. The resultant edges are made to converge upon the mid line. The inner edges of each incision are then raised upwards and united to each other by means of catgut sutures. The raw area outside is then united across the mid line by means of catgut Lembert sutures and the outer edges of the wound are united by means of fine salmon gut sutures which are introduced by the method of Edmunds.

These are really transposed Lembert sutures and ensure a wide union of parts. Plenty of sutures must be used but there must be no tension of the sutures except to secure proper apposition. This operation may not succeed in attaining its purpose but the surgeon if he has failed will not operate again shortly after the failure but care should be taken of any bridge of tissue that may be left as it may be most useful in further operations. But any surgeon will do well to remember what has already been touched upon namely the serious inferiority complex that may be set up by repeated unsuccessful operations for a congenital condition. In only one case of perineal hypospadias did the writer have a fatal issue and the very nervous condition of this patient and his behaviour before the operation led him to operate too soon rather than too late. He feels sure that it would have been better to wait and let the patient see that patients did come back from operations to their beds in a safe state. The patient died with suppression of urine and it may be that the kidneys were not in a good functioning state but clinically this possibility was not suggested until near the end.

Many operations must depend upon the surgeon's power of adaptation and this remark especially applies to the greater deformities and the names of Stiles and Moynihan stand out in connection with such use of special ingenuity and adaptability.

After no operation of the nature described should an instrument such as



a catheter be introduced. As John Hunter pointed out one hundred and fifty years ago a catheter *in situ* is a foreign body and as such does harm to the healing of any wound. On the other hand the surgeon must never be tempted to perform preliminary perineal section of the bladder for the urine is far too near the wound. He must always perform suprapubic cystostomy and plan things so that the urine does not contaminate the wound. As in other operations that have been described the patient should be allowed to get up as soon as possible and should occupy his mind with the usual work of the ward. The salmon gut sutures may be removed in ten days time or when union seems good.

It may be added that Willan of Newcastle has adopted most ingenious methods in transplanting veins with the object of reinforcing plastic methods hitherto described and form the skeleton of a new passage.

**Sacculus of the urethra**—This condition may occur either in the front of the urethra or in its first part but calls for small description now.

In the first place the glandular involution which forms the terminal part of the normal urethra may not meet the main part of the urethra thus making no connection with the urinary passage and thus a sacculus is formed but no urine collects in it and practically it may be disregarded here but it may cause some difficulty in catheterization especially in adult patients. Much more important than this anterior sacculus is the posterior one which occurs in connection with the sinus pocularis of the prostatic region. Attention will be given to this sacculus in another portion of this work (p 433). Suffice it here to state that such a sacculus may lead to false passages in the instrumentation of the patient especially in connection with the subjects of enlarged prostate.

**Multiple urethræ**—The meatal part of the urethra may grow back wards without entering the normal urethra and thus two passages are formed and in a few cases such a passage may never acquire any union with the normal urethra but lies alongside of it. Such a urethral duct may be the subject of gonorrhœa and such cases are apt to be particularly resistant to treatment.

**Congenital stricture**—The writer has had experience of three cases of this condition. All the subjects were about the same age *i.e.* fifteen years. In none of them was there the slightest evidence of gonorrhœa or of trauma including not only actual rupture of the urethra but also bruising of the passage walls. In one of the boys there could be no question of gonorrhœa. As these figures imply such cases are not common but that they occur the writer is convinced. They are possibly due to the junction of the meatal and penile parts of the urethra occurring further back than usual.

All the cases did well with simple dilatation of the stricture but in one case the stricture had led to ascending perinephritis on the right side and actual ascending nephritis on the left side. The stricture was dealt with very gently by dilatation and after this the left kidney was widely incised and permanently drained. After eighteen months the renal wound ceased to discharge urine and the wound healed well. After this the right kidney was cut down upon and the perinephric tissue was found to be suppurating. It was widely incised but the kidney was not itself incised. Later a stone developed in the right ureter or was passed along it from the affected kidney. This was removed and the wound has remained open in connection with the kidney ever since but showed signs of healing when last seen. Very little urine is passed through the wound and the boy remains perfectly well though actually he has reached manhood by now and has married and is the father of a healthy girl. The writer would humbly suggest that many cases that are now left to

die with this condition or that of other forms of stricture should be incised for ascending nephritis. Too much attention is paid to the incision of the bladder in such cases and not to the more important and life saving operation of incising the septic kidneys.

**Small meatus**—The meatus urinarus may be fully formed but very minute and no other deformity may be noted. It is only very rarely that it is not symmetrical being exactly in the middle line in the vast majority of cases. With the former congenital condition all the troubles of dysuria may be present and ascending nephritis may follow upon such a condition. When such a small meatus is met with whilst cystoscopy is contemplated or some operation involving the passage of a large instrument the meatus should not be forcibly dilated but the very thin part which forms its floor should be divided with scissors backwards and upwards. The instrument can then be introduced.

On the other hand the meatus may be found to be larger than is usual but in this state of things there is probably some mild deformity such as concealed hypospadias. Or the urethral passage may open at the ventral edge of the meatus thus enlarging it.

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## CHAPTER XXXII

### INJURIES OF THE MALE URETHRA

#### VARIETIES —

- (a) *Partial ruptures* are internal interstitial or aponeurotic according to whether the mucous spongy or investing fascial layer is torn
- (b) *Total ruptures* are those in which all the coats are involved
- (c) *Incomplete ruptures* are limited to a part of the circumference usually the roof remains intact (Fig 207 A)
- (d) *Complete ruptures* are those in which the whole circumference is broken (Fig 207 B)



FIG 207  
Ruptures of the urethra A Incomplete B Complete  
(From L. Guu and Pascau)

**DISTRIBUTION OF VARIETIES**—In the penile section rupture is usually partial and in the pendulous part incomplete in the bulbo perineal part it is generally total and incomplete or complete with about equal frequency In the membranous and prostatic sections it is usually total and complete

**COURSE**—The edges of a tear of the mucous coat are contused lacerated and inverted The gap heals by granulation tissue and fibrosis hence stricture formation aggravated by contact with urine and some degree of sepsis is the natural outcome Laceration and hæmatoma formation in the spongy coat lead to fibrosis which accentuates narrowing of the lumen If the fascial investment is ruptured there will be periurethral hæmorrhage In total ruptures urine will extravasate unless prevented by surgical aid In complete ruptures the ends contract and retract The degree of stricture formation is determined by these antecedents



FIG 208  
Lacerated wound of the penile urethra  
(From D. C. of the U. of C. and I. of the U. of C.)

#### RUPTURE OF THE PENILE URETHRA

**The pendulous section**—**ÆTIOLOGY**—Crushing or bending of the penis when erect may cause contusion injury to the urethra and body Wounds of warfare and those inflicted by savage races many of which are part of a social or religious ritual provide the majority (Fig 208)

**PATHOLOGY**—Hæmorrhage may be severe sepsis in a resultant hæmatoma may be the commencement of a spreading cellulitis Trauma to the urethra

is usually slight and with no great tendency to stricture formation but with wounds from transfixion or longitudinal incision stricture and fistula are likely to follow. A large part of the organ may be avulsed in wounds of war or otherwise received in an air raid victim under my care the penis was completely amputated by a bomb splinter which additionally ploughed through the perineum and destroyed the posterior urethra.

**TREATMENT**—Severe hemorrhage may be arrested by a firm bandage around the whole organ and this is more effective if exerted against the counter pressure of an indwelling catheter. The edges of wounds should be trimmed and sutured preferably in a transverse line to reduce the tendency to stricture.

**The perineo-bulbar section—ETIOLOGY**—The rupture is caused by compression of the tube between an external force and the unyielding background of the pubes and triangular ligament such as results from falls astride a rope or narrow beam. The degree of the force does not necessarily govern the extent of injury as in three personal cases. A middle aged colonel of light build slipped while getting over a low stile his perineum meeting the cross bar. A few hours later I found a complete rupture the deep end having receded 1½ in and through the triangular ligament. A boy of 14 whilst making a run at cricket caught the end of his bat in the ground and so forced the butt of the handle against his perineum. Several weeks later when sent to me suprapubic drainage had been established for an impassable stricture. I excised the stricture successfully by the Hamilton Russell technique (see p 401). A doctor friend fell astride the edge of a narrow metal plate and within a short time he noted hematuria. Micturition remained easy and as no perineal swelling appeared non operative treatment was adopted and was proved justified by the result. Warning as to a future stricture was duly given.

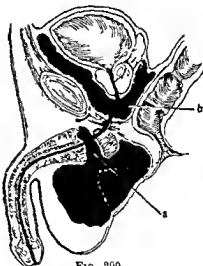


FIG 209

Areas of extravasation from ruptured urethra (a) below (b) above the urogenital diaphragm

(From *Diagnosis of the U. etc.* and *Pen. & D. Arcy* M. Crea.)

**Symptoms and signs**—Blood usually escapes from the meatus or mixed with urine when micturition is possible. Acute retention is present in complete and in most cases of incomplete rupture it is due to interruption of the mucous coat swelling from contusion and hemorrhage and to reflex sphincter spasm. Owing to this protective spasm extravasation is delayed. Pain is proportional to bladder distension. Extravasation is recognized by local and constitutional changes. Locally a perineal swelling which is at first more easily seen than felt develops. This may arise from extravasation of blood or urine or be merely the result of superficial contusion. If due to urine extravasation it will rapidly increase in size and spread to the scrotum penis groins and abdomen (Fig 209). Constitutionally extravasation of urine produces a toxæmia characterized by hiccough or vomiting pallor and many of the signs of shock.

A ruptured urethra may be symptomless and unsuspected until signs of a stricture arise after perhaps a lapse of years.

**Diagnosis**—The methods employed are applicable in all ruptures of the urethra.

(i) **NATURE OF INJURY**—The precise details of the accident should be ascertained a force directed against the perineum acting from before backwards hazards the bulbar section one from behind forwards the membranous the urethra in either case being compressed against the pubes Gross fractures of the pelvic girdle account for the majority of ruptures of the posterior urethra

(ii) **DISPOSITION OF EXTRUSION OF URINE**—When in the superficial planes this is easily recognized Where originating from a rupture deep to the urogenital diaphragm or spreading deep to it from the superficial planes in consequence of cleavage of the triangular ligament its existence may be problematical suggestive constitutional disturbance may arouse suspicion In obscure deep extravasation swelling or resistance will eventually appear above the groins in the lower hypogastrium and rectally above the prostate Skin discoloration in front of the anus may be noted Occasionally an accumulation in the cave of Retzius extends up into the hypogastrium as a swelling resembling a distended bladder

(iii) **EVIDENCE OF FRACTURED PELVIS**—Proof of this is an important step towards diagnosis of the ruptured posterior urethra and is supplied by recognition of altered bony landmarks and crepitus on examination of the palpable pelvic girdle including those parts felt from the perineum and by the rectum

(iv) **RADIOGRAPHY**—This will define the bone injury

*Contrast radiography*—This is seldom of practical value Excretion urography may show an area of extravasation Direct urethrography like all investigations requiring the introduction of fluid under pressure is harmful and should never be employed in the early stages its use is deferred to the time when surgical closure of a fistula is contemplated

(v) **URETHROSCOPY**—This is of little help since visualization without air or fluid distension both of which introduce dangers is unsatisfactory In diagnosis and treatment of strictures direct inspection may play a very important part especially with the aid of the posterior urethroscope

(vi) **THE USE OF THE CATHETER**—It is better for this to be deferred until its passage can be tried by an experienced surgeon in possession of a suitable instrument under appropriate surgical surroundings and prepared to proceed with any operative steps that may be indicated The outstanding risks are of increasing the damage already done by converting an incomplete into a complete rupture—the attenuated roof is a frail bond of union—and of introducing sepsis On the operating table the surgeon must pass a catheter to ascertain the position and degree of trauma to enable him to decide his procedure

## RUPTURE OF THE POSTERIOR URETHRA

**Ætiology** Contusion of the perineum may rupture the membranous urethra independently of or in continuity with a perineo bulbar rupture Fractures of the pelvic girdle or dislocations of the symphysis pubis are responsible for the majority of injuries to the posterior urethra yet it appears that the urethra escapes in 90 per cent of such skeletal traumas Wakeley (1929) found the incidence of urethral rupture to be little over 5 per cent

**Pathology**—The membranous part may be torn by the splintered ramus (Fig 710) or by the triangular ligament the prostatic is more liable to injury from fractures or dislocation of the pubes or to be gullotined by the deep layer of the triangular ligament Supported by the compressor urethrae linear alignment of the torn ends of the membranous section is preserved but

in the prostatic section there is no such support in the latter the pubo prostatic ligament yields and blood and urine escaping behind the symphysis force the prostate upwards and backwards thus breaking alignment which only appropriate surgical intervention can restore Urine will extravasate in the same direction as with extraperitoneal rupture of the bladder (Fig. 209 see p. 310) or may reach the superficial perineal planes when the urogenital diaphragm no longer acts as a barrier Extravasation preludes cellulitis abscess formation and fistula Fractured bones by contact with septic urine become infected osteomyelitis and necrosis follow

**Symptoms and signs**—Retention of urine is absolute Less blood escapes from the external meatus than with more distal ruptures Shock and pain from retention and fracture are marked External signs of extravasation are delayed perineal bruising may appear as an early indication of it



Fig. 210  
Fracture of the ramus causing rupture of the membranous prostatic urethra

(From Leuten and Pastur)

**Differential diagnosis** from extraperitoneal bladder rupture has often to be postponed until the operating table in obedience to the veto upon preliminary catheterization Pelvic cellulitis and venous thrombosis may both simulate extravasation of urine the former however usually shows higher pyrexia and the latter more marked edema of the penis and scrotum

### TREATMENT OF RUPTURED URETHRA

**First aid**—(1) With normal micturition and no perineal swelling three days rest in bed is ordered A perineal swelling although only hæmorrhagic should be incised Passage of a catheter is unnecessary Do nothing above all no exploration (catheterization) Marion (1921)

(2) With retention a distending bladder should be aspirated with an exploring syringe or intubated by the closed trocar cannula method the cave of Retzius being also drained

**Operations of repair**—It is often open to question whether (a) to expose the rupture early at the risk of finding tissues unsuitable for neat toilet owing to contusion and unequal to supporting sutures or (b) to delay hoping for local recovery but at the same time condoning to wider separation if the rupture were complete When the prostatic urethra is injured delay is only justified by inability to withstand operation In all operations passage of a catheter is the first step

(1) If a catheter withdraws several ounces of retained urine it should be tied in for forty eight hours A perineal swelling should be drained Sloughing of the urethra recorded when this method is adopted may be due to the use of too large a catheter or to imperfect peniurethral drainage



(u) If a catheter is checked near the triangular ligament, external urethrotomy is required the Trendelenburg lithotomy posture is adopted (Fig 211) and a Clutton bougie substituted for the catheter. The scrotum is retracted by pinning it around the penis. The end of the bougie is felt for in the perineum or per rectum to judge the location of the rupture. The incision will be medial, centred over the rupture when this is bulbo-membranous, as in the majority (Fig 212) or curved and transverse when membranous-prostatic. When exposed the bougie's end will disclose the type of rupture.

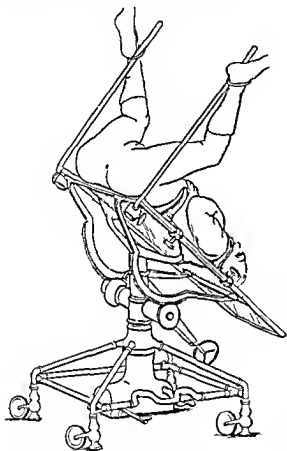


FIG 211

The combined Trendelenburg lithotomy position upon the operating table adopted for exposure of the deep urethra

(From *Diseases of the Urethra and Penis* D Arcey McCrea)

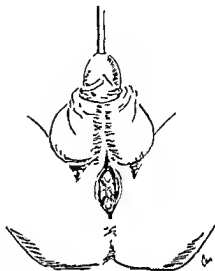


FIG 212

Incision for exploration of rupture of the bulbous urethra. Also suitable for impassable stricture where incision or excision is required. The scrotum is retracted by clips and a Wheelhouse staff is *in situ*.

(Courtesy of C A Wells)

If incomplete, withdrawal displays the roof and allows passage of a director (the Teale's gorget may be used) towards the bladder to aid passage of a catheter. Lacerated edges of the tear may be conservatively trimmed. Sutures are not required unless the roof appears frail, when tension may be eased by one or two stitches in the lateral walls. It should be remembered that restoring the legs to their normal position reduces tension and in fact, as Rutherford has pointed out allows apposition of the edges in most cases. I delay knotting stitches in any operation upon the fixed urethra until the legs are lowered, preparatory to this the ends are held in forceps. Many surgeons omit the indwelling catheter. I prefer one for forty eight hours and experience has not taught me that sepsis and stricture formation are thereby promoted. Suprapubic drainage is favoured even in the less severe incomplete ruptures by the majority of surgeons to day, urine deviation lessens the tendency to stricture.

If complete, the bladder should be immediately opened and a curved instrument passed in retrograde fashion to disclose the proximal end (Fig 213). The mobilized extremities of the whole thickness of the roof are trans fixed with sutures (usually three) of 00 catgut which are held in forceps; an additional stitch in each lateral wall may be desirable. All are arranged to be knotted on the mucosa as the legs are lowered. A catheter is passed along the whole length of the urethra to the bladder and held by a supporting stitch to the abdominal wall; it will be retained for a week. The bladder incision is closed around a Winsbury-White tube.

If the membranoprosthetic urethra is torn, usually at the apex of the prostate, suturing is seldom possible and reliance must be placed upon a "splint" catheter to preserve alignment. Transvesical, retropubic and perineal manoeuvres have been described to manipulate it into position. The displaced prostatic urethra may be reduced by digital pressure within the bladder (Nehgan 1941) and so allowing a steel bougie passed from the penis to traverse the whole length of the canal. In one case I was able to manipulate a curved steel bougie into the bladder by reducing the backward displacement of the prostate with a finger in the rectum. A rubber catheter can then be attached to its end and placed in position as the bougie is withdrawn. A method I have found useful is to bring the ends of penile and retrograde bougies out through the perineal wound and to thread over each the open ends of a length of plain (22 Fr) rubber tubing; these are drawn, respectively, up into the bladder and down the distal urethra. Splint catheterization is continued for at least a fortnight. Replacements can be effected by the railroad technique.

The retropubic space and other areas of extravasation must be thoroughly drained. Primary suprapubic deviation of the urine by aspiration or intubation may be all that is possible as a first aid measure.

Reconstruction is an arduous task in cases improperly treated in the initial stages, when perhaps failure to restore continuity has led to retention of suprapubic drainage. In them will be found an indefinable fibrous mass occupying the interval between the ramu and welded to them. It may extend to the bladder base and is often the seat of urinary fistulae. Ruthless removal of this mass is the first step taking care to preserve any lumen that can be disclosed by supporting bougies, retrograde or passed from without. Union between the distal end and the stump of the prostatic urethra or the bladder neck may be procured by the methods of Watson (1935) or of Young (1942).

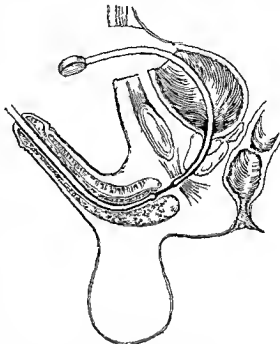


FIG 213

Penile and retrograde instruments used to define the lacerated ends of a ruptured urethra. A similar technique is a useful step in the course of operations for impassable strictures.

(From *Diseases of the Urethra and Penis*, D. Argy McCrea.)

Hamilton Bailey (1939) and Wells (1941), adopting the former's technique, reported successes. The distal urethra is separated as far back as possible and split horizontally with the formation of flaps which hinge at the bladder end

so that their extremities can be sutured to the stump of the prostatic urethra or to the bladder neck, the remainder of the circumference is formed by the process of natural repair. Continence after this operation is doubtful. In Young's method the corpora cavernosa are separated from their attachments and shortened drawing the penis under the pubic arch and so procuring contact of the parts to be anastomosed. The alternative to these or similar

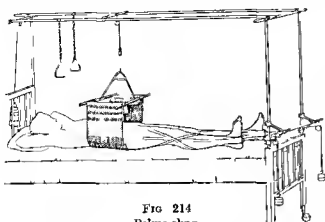


FIG 214  
Pelvic sling

(From *Surgery of Modern Warfare* Hamilton Bailey.)

devices, other than permanent suprapubic drainage, is ureterocolostomy.

An orthopaedic sling suitable for treating pelvic fractures complicated by trauma of the lower urinary tract in the early stages is shown in Fig 214. Some prefer the Watson Jones plaster spica.

### INJURIES OF THE URETHRA FROM INSTRUMENTATION AND GUNSHOT WOUNDS

**Instrumentation**—Passage of rigid instruments may traumatize a diseased or normal urethra by penetration or by splitting.

**THE DISEASED URETHRA**—Strictures and prostatic enlargements provide the commonest examples. (i) With *strictures* narrow instruments may penetrate the urethral wall causing false passages which may be submucous, interstitial or periurethral. Forceful dilatation with too large calibre instruments engaged in a stricture may split the inner coats longitudinally, as a finger may split a tight kid glove. (ii) With *prostatic obstruction* the accident may happen in the presence of either the simple or malignant gland. Penetration into the gland substance may result from forcing a bougie the tip of which is engaged in a pocket either distal to a prominent adenoma or to a transverse ridge (Guthrie's bar) sometimes found at the bladder neck. I have known such penetration transfix a middle lobe projection making a burrow through which catheter drainage of the bladder was successfully carried out for a week! At my subsequent enucleation of the gland the false passage within it was well defined. Transfixion may occur with the carcinomatous gland instruments having found their way into the periurethral tissue, the rectum and even into the peritoneal sac.

**THE HEALTHY URETHRA**—A narrow instrument may pierce the floor of an over-large crypt or lacuna but the most frequent traumas, often unnoticed at the time, occur as splits of the mucosa from the injudicious use of instruments of too broad a calibre, cystoscopes, endoscopic apparatus for prostatic punching or resection, lithotrites and the Bigelow cannula are the common offenders.

**Gunshot wounds of the urethra**—The nature of the wound will vary with the type of missile. Though lacerations are more to be expected with H.E.

fragments rifle bullets may indirectly cause almost as severe havoc if fracturing the pelvic girdle

Entry and exit wounds may be hypogastric inguinal sacral gluteal or in the upper thigh with injury of any structure in the missile's path thus bones vessels nerves anus rectum or the bladder may be simultaneously involved the peritoneum and its contents may not escape the external genitals are particularly exposed to injury

WOUNDS OF THE FREE PENILE URETHRA have been considered (p. 392)

WOUNDS OF THE PERINEAL MEMBRANOUS AND PROSTATIC URETHRA—The more commonly result from gunshot fracture of the pelvic girdle. In some recorded cases the missile was found lodged in the prostate in others in the urethral lumen in either case causing retention of urine

**PATHOLOGY**—This is an addendum of the characteristics of war wound sepsis complicated by the reactions to urinary extravasation varying with its duration of stagnation and to the raised tension established—haemorrhage and the gas product of anaerobes further raise tension and multiply the local destructive effects. A large urethral laceration will allow free superficial escape of urine and give vent to inflammatory discharges so modifying constitutional and local effects. Simultaneous involvement of the rectum or anus establishes a subcutaneous fistula or a cloaca like superficial wound from which urine and feces escape. A minute shell fragment or a bullet may cause a total but incomplete urethral rupture compatible with micturition yet allowing extravasation

**SYMPTOMS**—These are practically the same as described on pp. 393 and 395

**DIAGNOSIS**—The catheter will play a more prominent part than in subcutaneous ruptures— dangers incurred by its use are small in comparison with the damage the urethra is likely to have suffered from the violence of a missile's injury. Routine methods (p. 394) ranged under this heading are employed as the cases and circumstances indicate

**TREATMENT**—Excision of as much of the wound track as is within reach minimizes sepsis reduces the tendency to fibrosis and promotes more rapid healing subsequent plastic repair will thus be simplified. Drainage of extravasated blood and urine and incision into areas of cellulitis must be thorough. Powders of the sulphonamide compounds applied locally limit spread of infection. Toilet of the urethral wound is seldom helpful in the early stages. Urine from non viable tissue is difficult to determine—sutures would not hold. Young (1942) supports the use of the indwelling catheter on the evidence of case reports from the 1914-18 war. Suprapubic drainage is generally advisable occasionally a large perineal wound may be used for bladder drainage

**NOTE**—Effect of sulphonamide derivatives—To day when it is customary to use these orally or locally prophylactically and therapeutically for any injury liable to septic sequelae it should be recognized that the characteristics of urine extravasation may be considerably masked and therefore overlooked. Fever and toxic phenomena may be absent alteration of skin colour delayed for several days examination merely giving a suspicion of deep induration and superficial oedema. Occult extravasation none the less will be exercising its usual destructive effects and when exploration is eventually made a far worse condition of tracking sepsis and tissue death may be found than was expected from the vague signs. This note is added not to put an embargo on the use of these very valuable substances but as a warning of a possible pitfall. Penicillin may similarly obscure although minimizing the ill effects of a concealed escape of urine

## TREATMENT OF TRAUMATIC STRICTURES

Periodic dilatation is best carried out with curved steel instruments, the gum-elastic bougie is valuable when the stricture is shrunk to a narrow lumen or is tortuous

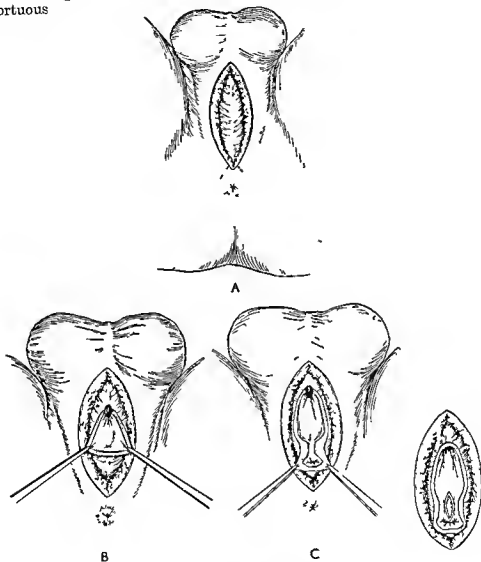


FIG. 215

Steps in External Urethrotomy for incision of stricture. The Wheelhouse operation  
 A, Incision exposing bulbocavernosus B Urethra opened in front of stricture  
 C Stricture laid open. Inset shows catheter in situ after incision of stricture  
 (From *Diseases of the Urethra and Penis* by D. Arcy McCrea)

Operative treatment may be necessary where excessive fibrosis in and around the urethral wall renders dilatation ineffective. Internal or external urethrotomy may be employed. The former serves in the milder cases distal to the urogenital diaphragm. The latter is reserved for the more fibrotic types and where the stricture is only passed with difficulty or is impassable, incision or excision is at the surgeon's disposal, and either is applicable to any part of the urethra. The special methods available for the prostatic urethra have been mentioned (p. 397).

**INTERNAL URETHROTOMY**—This is possible only with passable strictures. It is performed with the Maisonneuve instrument. A catheter (No 22 Charrière) is inserted after the cut is made and retained for forty eight hours.

**EXTERNAL URETHROTOMY**—The steps for exposure are similar to those described under exploration for the ruptured urethra. Inability to probe the lumen will call for the assistance of an instrument passed in retrograde fashion either through a more proximal incision in the urethra or usually transversely. The urethra on either side being thus incised the strictures may be incised (Fig 215) or excised (Fig 216). The latter is preferable and not difficult unless the stricture is deeply placed and complicated by periurethral fibrosis.

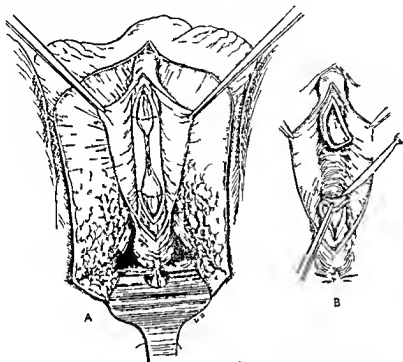


FIG 216

Excision of stricture. A Stricture exposed. B Stricture excised.  
(From *Lectures on the Urethra* and *Urethral Surgery* by M. Cres.)

**EXCISION OF THE STRICTURE**—The whole thickness of the urethral wall on either side of the stricture is mobilized by undercutting by which the strictured area can be isolated and raised from its fibrous bed preparatory to removal. Enough is excised to leave supple ends showing an adequate vascularity (Fig 216). For the remainder of the operation my personal choice is given to the technique of Hamilton Russell (1915) where roof suture in ribbon fashion is alone employed the floor and sides being formed from condensation of surrounding parts. A catheter may be left in the whole length of the canal for a few days but this appears to be unnecessary. Russell inserted a tube from the perineal wound to the bladder leaving the remainder of the channel to take care of itself. He claimed subsequent freedom from stricture and future dilatation unnecessary.

**INCISION OF STRICTURE** broadens the lumen by linear cuts made when possible upon a probe traversing it. It is suitable in the milder cases especially those following incomplete rupture.

*Post operative dilatation of traumatic strictures* must be accepted as the rule which applies equally to the most mild and to the most severe. The length of interval between the dilatations must be decided in each individual case and there is no time signal for discontinuance of such treatment. It appears, however, that with the progress of time indeed after the first twelve months the tendency to contraction is much diminished in conformity with this peculiarity of fibrous tissue elsewhere.

The surgery of repair for closure of fistulæ and reconstruction of urethral defects is on p. 408.

JOHN EVERIDGE

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## CHAPTER XXXIII

### FOREIGN BODIES, CYSTS AND FISTULÆ OF THE MALE URETHRA

#### FOREIGN BODIES IN THE MALE URETHRA

THE number and variety of foreign bodies found in the urethra and bladder (see p 334) are legion although rare in regard to the number of patients seen. Most foreign bodies in the urethra have been introduced through the external meatus. Sometimes the foreign body is the result of instrumentation. A filiform guide may become detached from the follower but this generally reaches the bladder. This accident may be due to the fact that the connection is worn and unfit for use or to a faulty and loose screw connection. That firm union is present should be accurately determined before the follower is passed. Many screw connections have faulty and inaccurate threads due to lack of engineering standardization amongst instrument makers and unless the surgeon is mechanically minded and realizes this and tests the connection meticulously before use catastrophes will occur. A gum elastic catheter which has perished may also break and a portion be left in the urethra. A lithotrite has been known to cause trouble and become a foreign body the mechanism failing to work when the blades were open in the bladder.

In children a foreign body may be introduced into the urethra as a result of mischievous or inquisitiveness *e.g.* a pea, a fruit kernel or a thread of wire. The same occurs in the nose or ear. Usually however the patients are mental defectives, erotics or the inmates of lunatic asylums. Wire, wax, candle grease, pins, chalk and pencils have all been found. The chief culprits are erotic adolescents the type who indulge in masturbation. Sometimes the introduction of foreign bodies such as wax and candle grease is resorted to in an endeavour to check nocturnal emissions or to prevent discharge when gonorrhœa is present. An abnormal mind is obviously the author of either procedure.

It is difficult to explain how a foreign body ascends the urethra and passes the external sphincter. Efforts to extract it milking the penis alternating erection and relaxation are possible explanations. A flexible wire passed along the urethra and into the bladder may be fully pulled in as a result of the bladder filling and emptying. As the bladder contracts the wire will be kinked and folded together which will prevent its extrusion. Filling of the bladder will allow more of the wire to be pulled in especially if it becomes entangled in a trabeculation in rugæ or by perforation of the mucous membrane.

Complications of foreign bodies in the urethra are rare. Urethritis, abscess, fistula, hæmorrhage and dysuria occasionally occur. Very often the duration of a foreign body is short the flow of urine being sufficiently strong to eject it.

Diagnosis—This can usually be inferred from a history of the case but X rays, palpation or urethroscopy will make the diagnosis certain.

Treatment—If a foreign body can be palpated within 3 in. from the meatus an alligator forceps will often suffice for its grasp and removal. In other cases



an operating urethroscope can be used, the foreign body seen and grasped by forceps and extracted. Occasionally in the prostatic urethra the foreign body can best be pushed into the bladder by a large bougie and removed suprapubically or with an operating cystoscope. A broken gum elastic catheter is most easily removed suprapubically. Rarely a perineal urethrotomy will be necessary. This will be essential in the case of a retained lithotrite, and also an engineer assistant to divide the shaft, after which one part will be removed suprapubically and the other withdrawn through the meatus. Wax or candle grease which fails to come away with forceps can be dissolved with xylol, 1 oz. of which is injected into the urethra. This is retained for an hour by clamping the penis and on removing the clamp the xylol with the dissolved foreign body will flow away. The urethra should then be irrigated, although xylol is seldom irritating to mucous membrane. A pin is easily removed. It is generally introduced head first. To remove it the pin is manipulated and the point thrust through the floor of the urethra and penis. It is then reversed and gently pushed along the urethra towards the meatus, when the head can be grasped and the pin extracted.



FIG 217

Urethroscopic view of the internal meatus showing multiple cysts  
(From *Operative Cystoscopy* E. Cannon Ryall)

### CYSTS OF THE URETHRA

Cysts of the urethra are not uncommon, but they so rarely give rise to symptoms that they are not suspected although often found in urological clinics at routine urethroscopic examinations. They may occur anywhere in the urethral canal where glands or ducts are present, and may be large or small, single or multiple. The commonest site is the prostatic urethra.

**Ætiology and pathology**—Cysts of the urethra are mostly retention cysts. Gland ducts become blocked by inflammation and the gland acini enlarge coalesce by the destruction of intervening tissue and thus

form a cyst. Usually only the orifice of a duct becomes occluded, in which case the duct will become cystic. Cowper's gland itself seldom dilates and becomes cystic because it is closely surrounded by muscle, but the duct which lies under the mucous membrane of the bulbous urethra is chiefly affected. The largest cysts in the urethra are those of Cowper's ducts or in the prostatic urethra near the internal meatus where the cyst can be extruded into the bladder and readily enlarges because it becomes free from surrounding pressure. Cysts of the prostatic urethra may be very numerous but they are always small, because of the firm pressure exerted by the approximated lateral lobes. Sometimes the cysts have the appearance of small glistening pearls embedded in the mucous membrane. A cyst is usually distended with a pale milky or yellowish fluid which contains no formed elements. The wall of a cyst may be so thin that the passing of a steel bougie will rupture it. Often, however, the wall is thick and tough, and considerable fulguration will be necessary for its destruction. A past history of gleet and gonorrhœa is obtained in most cases when cysts are found. At autopsies of the newly born, cysts have been found springing from the sinus pularis. They are probably retention cysts due to some developmental malformation.

Cysts may sometimes form as a result of submucous accumulation of lymphoid cells which later undergo central liquefaction. These generally contain a pale yellow fluid. They usually occur in the prostatic urethra and at first appear as pale raised areas surrounded by hyperæmia. They may be round or oval the long axis being always in line with the urethra never transversely and are chiefly found in the floor of the urethra. They are lymphocysts due to a tuberculous toxin liberated from some distant active focus. Very rarely the tubercle bacillus has been found in the local lesion. These cysts do not respond to local treatment but always recur so long as there is an active focus of tuberculosis. The general appearance is that of chronic follicular prostatitis and if local treatment and prostatic massage fail to cure the condition then the existence of a toxic lymphocystic lesion should be considered.



FIG. 18

Cyst of the prostatic urethra as seen through the urethroscope extruding into the bladder



FIG. 19

Diagrammatic drawing of above  
(From *Operative Cystoscopy* E. CONNELL)

A cyst can always be distinguished from bullous œdema by the fact that very fine vessels can always be seen coursing along the surface of a cyst whereas bullous œdema is avascular.

An adenoma may undergo degeneration and give rise to a cyst.

**CLASSIFICATION**—Cysts may be congenital or acquired. The former are sometimes found at autopsy in the newly born and in the living infant may be inferred if there is two or three days delay in voiding urine and a slight yellowish discharge precedes the onset of micturition or occurs during catheterization. Congenital cysts are situated in the region of the sinus pectus and the common ejaculatory ducts. They are retention cysts due to occluded duct orifices the result of some developmental error.

Acquired cysts are generally retention cysts due to inflammatory occlusion of duct orifices but sometimes result from cellular degeneration. The following varieties are found: Cowper's gland cysts, Littre's gland cysts, cystic adenoma, cystic dilatation of the sinus pectus or of the common ejaculatory ducts, retention mucous cysts.

**Symptoms**—A cyst of the prostatic urethra which has become extruded into the bladder may act as a ball valve and cause acute retention of urine. In other cases a certain amount of urinary stasis may occur with subsequent infection, cystitis and urethritis.

A cyst of Cowper's gland may rarely be so large as to form a prominence in the perineum. It may irritate the external sphincter and so give rise to symptoms of spasmodic stricture.

Cysts in the region of the verumontanum are often associated with sexual neurasthenia, impotence and premature ejaculations.

Chiefly the symptoms of urethral cysts are those of mild urethritis, e.g. frequent micturition, burning feeling at the external meatus on cessation of the act, a gleet, sterile discharge, sometimes slight hæmorrhage on instrumentation and a dull ache or pain and discomfort in the perineum.

**Diagnosis**—This can only definitely be made with the urethroscope. Cowper's duct cyst will be seen as a fusiform swelling on the floor of the bulbous urethra. It may be single or multiple and if the cyst has ruptured then one or two large openings may be seen resembling false passages. Differentiation between the two conditions cannot always be made unless the smooth lining of the cyst is visible. Possibly many an assumed false passage is a ruptured cyst of Cowper's duct.

Cysts of Littre's ducts are small and multiple and are to be found in the anterior urethra. They are often surrounded by slight hyperæmia. The commonest site of cysts is the prostatic urethra, usually in the floor or attached to the free border at the internal meatus. Here a large solitary cyst may be seen protruding into the bladder or multiple cysts each the size of a small pea. In the floor of the prostatic urethra cysts are small and numerous and granulations and patent ducts may also be seen. The condition often resembles one of chronic posterior urethritis or follicular prostatitis.

**Treatment**—Small cysts may be ruptured and the condition cured by a course of dilatation with large steel bougies Clutton 28/32 or with Kollmann's dilator fully extended. An intra urethral injection of acriflavine or argyrol should be given after each dilatation to lessen possible infection. Large cysts should be fulgurated and destroyed with an electrode passed through an operating urethroscope. It is not sufficient merely to puncture the cyst or it will reform. The whole cyst wall must be destroyed. A Cowper's duct cyst can be successfully treated urethroscopically, but if it is a cyst of the gland which causes a swelling in the perineum then it must be dissected out through a perineal incision.

## FISTULA OF THE URETHRA

**Ætiology and pathology**—Fistula of the urethra is not as common as it used to be because patients earlier attend for treatment and so the conditions which lead to fistula are less likely to occur, e.g. neglected stricture and inflammation. The causes of fistula are trauma, inflammation and new growth.

**TICOMA**—Internal injury to the urethra may be caused by calculus, foreign body, instrumentation, electro coagulation or chemical agent.

An impacted urethral calculus may cause pressure necrosis and sepsis. The urethral wall perforates, urine leaks and the resulting sinus becomes infected and forms an abscess which may burst externally. A small jagged calculus may abrade the urethra while in transit and lead to a similar condition. The fistulous opening is not always in the perineum but often in the pendulous part or at the root of the penis dorsally. Efforts to extract the calculus may cause more serious damage to the urethra than if it were left to Nature for its extrusion or removed at a formal urethrotomy.

A large solid foreign body may become impacted and react similarly as a calculus. A pin, nail, wire, sharp or rough implement may pierce or tear

the mucous membrane, leading to sepsis. The sooner a foreign body is removed the less likelihood is there of complications developing. Instrumentation may rupture the urethra by causing a false passage. This is unlikely to happen if small calibre metal bougies or catheters are not used. Metal bougies which have lost their polish rusted and become rough are liable to injure the urethral mucous membrane. A urethroscope sheath may have a sharp edge or a faulty obturator and cause injury, and sometimes a catheterizing cystoscope has been withdrawn from the bladder with the Albarran lever wrongly adjusted, or a lithotrite withdrawn while the blades are separated. Injury to the urethra by faulty surgical technique is not infrequently followed by sepsis, abscess and fistula.

Electro coagulation, if excessive, will lead to extensive necrosis, urinary extravasation abscess and fistula. The cutting electric current when misused will give a similarly bad result. Extravasation in these cases may occur within a few hours or, if preceded by abscess or cellulitis, within three or four days. Sometimes urethral injury following endoscopic operations is due to an indwelling catheter of too large a calibre.

Fistula often results from external damage to the urethra. In war this is from bullets and pieces of shell casing, and occasionally from an adversary's bayonet. Sometimes in these cases a portion of the penis dorsally near the root is carried away and a large opening in the urethra exposed.

In civil life, stab wounds or impaling accidents may cause a fistula, or falling astride a blunt object may rupture the urethra, with resulting septic or surgical fistula. Most fistulæ due to civil accidents open into the perineum, whereas those due to sepsis occur anywhere along the penis, in the scrotum, or in the perineum.

Surgery is responsible for the actual fistula in many cases, but is not always blame-worthy, for it is an essential act in treating extravasation, abscess, cellulitis or impassible stricture. Fistula following perineal prostatectomy, however, is a complication of surgery and may be serious and difficult to cure, e.g. a recto urethral fistula.

Circular constriction of the penis, which has been done by erotic adolescents to prevent nocturnal emissions, and by others to cure a gonorrhœa, occasionally has caused injury to the urethra with resulting sepsis and fistula.

**INFLAMMATION.**—This is generally associated with urethral fistula, and in most cases, apart from external trauma, is the actual cause. In all cases the inflammatory process progresses from a urethral lesion. Many of these have already been referred to, but the majority of urethral fistulæ are due to rupture of the urethra proximal to a stricture.

This rupture may lead to extensive extravasation or may be merely a leakage. If the first, then extensive cellulitis, pointing septic foci and often multiple fistulæ quickly become apparent. During micturition the perineum may resemble the rose of a watering-can, urine pouring from many fistulæ at the same time. If there is only a slight leakage an abscess forms, but if this is neglected, either by the patient not seeking advice or by wrong treatment by the doctor consulted, the abscess will enlarge and burst. If it points and bursts through the skin only one fistula will result, but usually the abscess bursts internally and produces many ramifications in the cellular and muscular tissues. Ultimately multiple fistulæ become evident, with or without the intervention of surgery. Often treatment is so delayed or ineffective that massive perineal induration supervenes, and may be so deceptive as to mask the presence of malignant disease.

Sometimes a fistula forms in the penile urethra, on its ventral aspect, and

gives rise to no symptoms urine passing normally without any escaping through the fistula. If fluid is injected through the meatus however it will leak through the fistula.

Tuberculous urethritis is relatively rare but when it occurs destruction is extensive. It gives rise to multiple fistulae with ramifying tracks suppuration and massive induration. When it occurs it is generally associated with marked genito urinary tuberculosis.

**NEOPLASM**—Carcinoma of the urethra may not be recognized until the stage of fistulae and is often only diagnosed after microscopy of curettings from these. It is sometimes difficult to say whether a carcinoma has arisen in a fistula or merely invaded it. The question however is of no practical importance for the prognosis is bad in either case.

**Symptoms**—These are self evident. An escape of urine from the perineum or rectum or bubbling of gas through the meatus is unmistakable. A blind fistula or urethral sinus can only be diagnosed with certainty at operation although a urethrogram will sometimes suggest the condition. A swelling forms in the perineum and is incised. It may be a simple abscess. In most cases however pus and urine are liberated which indicates rupture of or leakage from the urethra. A stricture is generally present.

**Treatment**—This will depend upon the nature and extent of the fistula. There is no formal operation but each case needs study and the remedy will depend largely upon the ingenuity of the surgeon. There is one essential however requisite for the success of any plastic operation upon the urethra. That is the complete diversion of the urinary stream which can only be fully obtained by suprapubic drainage of the bladder. An indwelling catheter not only fails to prevent urine from trickling down the urethra and so soiling and irritating the line of suture but it also causes a certain amount of urethritis which normally a healthy urethra can cope with for a limited time without much harm but which definitely prevents union in a plastic operation and thus is inimical to successful repair. No plastic operation should be attempted while sepsis is rampant. General and antiseptic treatment will be necessary as a preliminary. Urethral mucous membrane proliferates rapidly much quicker than skin epithelium and so the encouragement of a granulating surface is useful.

Many cases of fistula are cured by simply draining the bladder cauterizing the fistula and dilating a stricture.

A small penile fistula near the corona if it does not leak urine may be left alone for two reasons. Firstly it usually causes no discomfort or disability and secondly the tissues are so thin that a primary repair operation is likely to fail and subsequent operations will be unsuccessful because of the avascularity of the scar tissue. This type of fistula should only be operated upon if urine escapes or if it becomes a cause of sterility. The operative procedure is as follows —

- 1 Excise the fistulous track
- 2 Separate the mucous membrane from the submucous tissue and stitch the mucous membrane together with fine catgut
- 3 Separate the skin from the subcutaneous tissue
- 4 Suture the deep tissues together
- 5 Suture the skin

The lines of suture must be so planned that they cross but do not overlap. Any of the operations devised for the closure of a hypospadias may be made use of in the treatment of penile fistula. Often several operations may be

necessary before a success is obtained. The difficulty in operative treatment is the thinness and lack of tissue to be dealt with.

Fistula at the root of the penis on the dorsum is generally single and often heals after the track is cauterized with silver nitrate or the electric current. Perineal fistulæ must be operated upon unless malignant disease is present. Preferably the endothermy knife should be used so as to control hæmorrhage and minimize sepsis. All fistulous tracks must be broken down so that one large cavity is formed instead of several small ones. As much as possible of the indurated tissue should be excised so that the cavity will have shelving sides or become almost a flat surface. The wound should be packed lightly with gauze soaked in acriflavine in glycerine (1 in 1 000) and allowed to heal by granulation. If a stricture is present internal urethrotomy should be carried out first or, if this is not possible treatment should be as described for external urethrotomy.

If much tissue involving the scrotum and base of the penis has to be excised then when a suitable granulating surface has developed a certain amount of skin grafting will be helpful in minimizing the subsequent contraction of scar tissue which otherwise might lead to flexion deformity of the penis. Suprapubic drainage must be continued until the perineal wound is soundly healed.

Recto-urethral fistula is difficult to cure. The rectum must be freely dissected from its connections with the urethra, the fistulous opening defined, its edges excised and then closed and buried by superimposed sutures. Occasionally a portion of the rectum may have to be removed. A colostomy is seldom necessary. If the opening into the urethra is large it may be closed by suture otherwise the wound is packed with gauze and allowed to heal by granulation.

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## CHAPTER XXXIV

### NEW GROWTHS OF THE MALE URETHRA

#### BENIGN GROWTHS

**T**HESE are relatively common, although the symptoms are so slight and indeterminate that they seldom suggest a diagnosis. Growths are only discovered on urethroscopic examination, clinically they are rarely suspected.

**Classification**—Fibroma, myoma, adenoma, papilloma, polyp, granuloma. **FIBROMA AND MYOMA** are very rare. They are small, hard, encapsuled tumours and are only discovered post mortem.



FIG 220  
Polypus at the internal meatus



FIG 221  
Papilloma of the prostatic urethra extending into the bladder. Several small cysts are also present.

(From *Operative Cystoscopy* E. Canny Ryall)

Adenoma, papilloma and polyp are indistinguishable clinically, and are usually referred to as polypoid tumours. Their true classification is apparent only on microscopic examination.

**ADENOMA**, sometimes called glandular polyp, may arise anywhere in the urethra but is chiefly found in the prostatic urethra. It may be sessile or pedunculated, and is covered by normal epithelium. It consists of a fibrous stroma containing blood and lymph channels, and acini lined with columnar epithelium, which in places may be infolded and papilliferous. Adenomata may arise from the submucous glands or from prostatic tubules.

**PAPILLOMA**, or villous polyp, is commonest near the extremities of the urethra. It contains little stroma and is highly vascularized, the epithelium sometimes lying almost directly on the walls of the capillaries. Papillomata tend to recur, and if near the vesical orifice may become malignant.





FIG. 202  
Polyp of the posterior urethra  
(From *Operative Gynecology* L. Canny Ryall)



FIG. 203  
Polypoid tag of mucous membrane



FIG. 204  
Polyp and adenoma on the verumontanum  
(From L. Canny Ryall's collection)



FIG. 205  
Papilloma on the verumontanum



FIG. 206

Polyp on the verumontanum  
(From L. Canny Ryall's Collection)



FIG. 207

**FIBROUS POLYP** is the commonest urethral growth of an innocent nature. It occurs anywhere along the course of the urethra, but chiefly in the region of the verumontanum. It is more fibrous and less vascular than the villous polyp, and is cedematous and infiltrated with round cells and leucocytes. It resembles the nasal polyp inasmuch as it indicates deep-seated chronic infection usually prostatitis or seminal vesiculitis. It is often associated with stricture. It is pale semi translucent and disappears when the local infection is cured. It occurs in numbers and occasionally the whole urethra may be involved.

**GRANULOMA** or an inflammatory growth, comprises granulations, bullous oedema and cedematous epithelial tags, usually the result of faulty instrumentation.

The term condyloma should not be applied to urethral tumours, although it was usual before the days of accurate microscopy. Condylomata are venereal warts, which affect the glans penis and may encroach upon the urethra, but they never originate in the urethra. They are more fibrous and less vascular than urethral growths and are always inflammatory.

**Symptoms**—Hæmorrhage usually follows instrumentation but otherwise is very slight in amount and transient. If profuse, one should suspect the presence of a papilloma (villous polyp).

Discharge is common especially if the cause be fibrous polyp. These often give rise to prolonged and uncured gleet.

Pain apart from slight urethral irritation and discomfort, is due to the causative condition, and therefore only occurs in cases of fibrous polyp, because they are generally associated with chronic prostatitis or seminal vesiculitis. The pain occurs in the perineum, and may be neuralgic in character. Usually there is a dull ache in the perineum, with a feeling of heaviness.

Frequency of micturition may occur, due to local irritation.

Dysuria depends upon the degree of associated urethritis.

Sexual disturbances may occur, and occasionally sterility and impotence have been cured by the successful treatment of polyp.

**Diagnosis**—In so far as tumour is concerned this can be made with the use of the irrigating urethroscope, but the type of growth present can only be classified accurately after microscopy. Associated urethritis or the presence of stricture suggests the condition to be one of fibrous polyp. This is important in regard to treatment.

**Treatment**—Fulguration by diathermy through an operating urethroscope will ablate all benign growths of the urethra and this is the modern procedure. Papillomata however, although happily very rare may recur and in their recurrence may become malignant. Fibrous polyp will recur unless the underlying inflammatory cause is also treated and cured. This consists in full dilatation with metal bougies, prostatic massage, milking of the vesicles, and intra-urethral instillations of  $\frac{1}{2}$  per cent silver nitrate solution, 20 per cent argyrol or acriflavine in glycerine (1 in 1,000).

### MALIGNANT GROWTHS

These are very rare. According to Hinman there have been 250 reported cases, and about half of these occurred in females. In Pondville Hospital (U.S.A.), which is entirely devoted to neoplastic diseases, in fourteen years out of a total of 19,000 cases there was only one case of carcinoma of the male urethra up to 1941. The disease occurs about as often in females as in males.

Why the urethra should be so immune from malignant disease it is impossible to say unless urine contains some anticarcinogenic principle for which as yet there is no recorded evidence

**Ætiology**—Trauma a noticeable antecedent of carcinoma in other parts of the body is not particularly significant in the case of the urethra. Stricture and its treatment by repeated dilatation are said to be crucial because so many cases give a history of previous stricture. It must be noted however that strictures are very common whereas carcinoma is very rare also that in females carcinoma occurs as frequently as in males yet in females stricture is very uncommon. The same reasoning applies to negative irritation from chronic infection and resulting patches of leucoplakia as being causal. The theory of embryonic cell nests (Conheim) and lessened cellular resistance (Adam) appears to be the only rational explanation.

**SEX**—The incidence of carcinoma is about equal in both males and females.

**AGE**—The disease generally affects people in adult life from 50 to 60 years although a case has been reported at the early age of 22 years.

**Classification**—Sarcoma carcinoma

SARCOMA is so rare that it need only be mentioned as a possible occurrence.

CARCINOMA according to Robb (1928) from a study of 76 cases may be typed as squamous celled in 73 per cent columnar celled in 15 per cent papillary in 35 per cent adenocarcinoma in 21.2 per cent transitional celled in 13 per cent.

In 61 cases collected by Diehl the situation was membranous urethra in 33 cases pars cavernosa in 26 cases fossa navicularis in 2 cases.

Hinman's figures are pars cavernosa in 52 per cent bulbous urethra in 25 per cent membranous and prostatic urethra in 22 per cent.

In connection with these tables it should be noted that the cells of the mucous membrane are transitional in the prostatic urethra columnar in the membranous and bulbous urethra squamous in the fossa navicularis.

The preponderance of cases of squamous carcinoma in a region not lined by squamous epithelium suggests the presence of embryonic cell nests or of leucoplakia and metaplasia.

**Pathology**—The carcinoma spreads along the mucous membrane and invades the surrounding tissues viz the corpus spongiosum and the corpora cavernosa. Infection of the tumour generally occurs and causes abscesses and perineal fistulae. The carcinoma extends down the fistula so frequently that the question arises Has it originated in the urethra or in a pre-existing fistula? Often the diagnosis has only been made after microscopy of curettings from fistulae and sinuses.

Carcinoma may originate in the glands of the urethra or a simple papilloma may undergo malignant change. There are three recorded cases only of carcinoma originating in the glands of Cowper. Lymphatic extension is late and involves the sacral iliac and inguinal glands. Metastases occur in the ribs vertebrae liver and lungs but the rate of growth varies and may be a question of months or years. Taking into account the differences of lymphatic spread symptoms and amenability to treatment Young adopts Imbert's classification viz carcinoma of the pendulous urethra carcinoma of the deep urethra. This is a clinical classification and much more practical than a pathological one.

**Symptoms and signs**—Carcinoma of the pendulous urethra should be detected in an early stage of the disease. The patient complains of a lump or induration in the penis which may cause curvature on erection. When

ulceration occurs it gives rise to slight hæmorrhage and urethral discharge. If the inguinal glands become enlarged this may be due to carcinomatous extension or to sepsis. Pain is absent and abscesses, fistulæ and stricture only occur in neglected cases.

Carcinoma of the deep urethra may be difficult of early diagnosis. No noticeable lump is experienced by the patient, and the first symptoms may be those of stricture. When these occur in a patient with a clean venereal history suspicion of carcinoma should arise. In delayed stricture, abscesses, perineal fistulæ and sinuses may first be noticed. These are generally accompanied by marked induration partly due to carcinomatous infiltration and partly to sepsis. The inguinal glands may not be enlarged, but rectal examination may reveal enlargement of the sacral glands. Hæmorrhage, slight only in the absence of instrumentation and urethral discharge are common. Pain and discomfort are no more than can be accounted for by the accompanying sepsis. Often the condition of carcinoma is only diagnosed after microscopy of curettings of the sinuses or fistulæ.

Urethroscopy is essential in the diagnosis of urethral carcinoma. If the carcinoma produces a stricture that prevents the passage of a urethroscope the mucous membrane will be seen to be altered in appearance. It will be fixed, rugose, irregular, and bullous œdema will be present. If the stricture is not sufficiently narrow to obstruct the passage of the urethroscope, the carcinoma will appear as an ulcerated excrescence, friable and hæmorrhagic. If a Geiringer water irrigating urethroscope is used, the bleeding will never be sufficient to obscure an accurate view or prevent a diagnosis. Removal by forceps of a portion of the growth for biopsy is occasionally useful to confirm the diagnosis, but as infiltration of the mucous membrane is the essential characteristic of cancer, biopsy of surface cells may be misleading.

**Differential diagnosis**—Carcinoma has to be distinguished from syphilis, tuberculosis, chronic inflammatory induration and cavernous fibrosis.

*Syphilis* of the urethra is now uncommon because of early diagnosis and efficient treatment of the primary lesion. The suspicion of gumma, however, should always be present and if a Wassermann test be positive a course of specific treatment should be given and its effect noted before making a diagnosis of carcinoma.

*Tuberculosis* of the urethra is almost as rare as carcinoma, but when present the local conditions are similar. However there are other manifestations of genito-urinary tuberculosis so the correct diagnosis should not be difficult.

*Chronic infection*, the result of stricture with abscess, fistulæ, sinuses and induration may obscure an accurate diagnosis, and carcinoma is sometimes discovered only on microscopy of curettings from a sinus or a fistula. Enlargement of the inguinal glands is not significant, because it may be due to either carcinoma or sepsis. Urethroscopy is an invaluable aid to distinguish the two conditions. If carcinoma is present bullous œdema, hæmorrhagic excrescences and submucous infiltration will be evident.

*Cavernous fibrosis* affects the corpora cavernosa and occurs as a dorsal induration of the penis without any involvement of the urethra. There are no symptoms beyond the presence of induration and distortion of the penis on erection. The inguinal glands are not affected.

**Treatment**—Carcinoma of the pendulous urethra should be an early diagnosis, in which case amputation of the penis and removal of the inguinal glands is justifiable, followed by a course of deep X-ray therapy.

Local removal of the growth and plastic repair operations although such have been attempted are not justified by the results

Carcinoma of the deep urethra is inoperable The insertion of radium needles into the growth is indicated following the establishment of permanent suprapubic drainage

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## CHAPTER XXXV

### THE FEMALE URETHRA

#### ANATOMY

**T**HIS channel is about 4 cm long, 6 mm in diameter and extends from the neck of the bladder to the vestibule. It passes almost directly downwards behind the symphysis pubis, with an inclination forwards, and a slight concavity in the latter direction. In the first part of its course it occupies the pelvis, in the middle part it lies between the two layers of the urogenital diaphragm, and in the third part it lies deep to the anterior vaginal wall.

In front it is in relationship from above downwards with the plexus of Santorini, the aponeurosis which lies between the urethra and the symphysis pubis, and the junction of the two roots of the clitoris. Behind is the anterior vaginal wall to which it is loosely joined by connective tissue in the upper part and intimately attached below this.

Laterally from behind forwards it makes contact with the levatores, the connective tissue containing the internal pudendal vessels and the vestibular bulbs and sphincter of the vagina.

**The external urinary meatus**—This is situated on the vestibule about 2 cm behind the clitoris, a little in front of the forward extremity of the anterior column of the vagina. It may appear rounded, stellate, or as a vertical slit. On each side of the meatus is the opening of a para-urethral gland of Skene. Sometimes each lies just within the meatus.

**HYPERTROPHY**—This occurs as an overgrowth of all the structures at the meatus which is thus carried forward beyond the level of the vestibule to form a soft firm collar with an irregular margin. The projecting mass may become inflamed and even give rise to hæmorrhage. It should be excised after inserting sutures by the same technique as described below under Treatment of Urethral Prolapse.

**Structure**—The urethra has two principal coats, the mucous and the muscular, connected by a zone of loose connective tissue which contains a plexus of large veins, the latter also extends between the neighbouring longitudinal muscle fibres.

**THE MUCOUS MEMBRANE**—This is lined by cylindrical stratified epithelium which becomes transitional near the bladder. Some simple tubular glands exist in the mucous membrane while in the submucous tissue there are glands of a more complicated structure. The glands are found only in the anterior portion of the canal.

**THE MUSCLES**—The muscular coat is continuous with that of the bladder. It consists of an inner layer of longitudinal non striated fibres and an outer layer of circular non striated fibres, in addition to these two layers there are also some striated muscle fibres. These are pronounced in the uppermost fourth of the channel where they are massed in sphincter-like form and between the two layers of the triangular ligament where they form the sphincter of the membranous urethra. Well developed venous channels are to be noted in the muscular coat, particularly amongst the longitudinal fibres.

**ARTERIES AND VEINS**—The arterial supply is from the inferior vesical and vaginal arteries. The veins drain into the neighbouring plexuses the plexus of Santorini and the bulb of the vagina.

**NERVES AND LYMPHATICS**—The nerve supply is through the internal pudendal from the hypogastric plexus. The lymphatic drainage is into the external iliac glands.

### EXAMINATION

**Inspection**—The patient should be placed in a urological chair with the thighs conveniently separated and a good light directed on to the vulvæ.

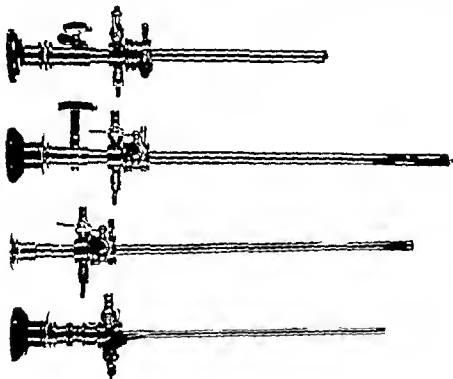


FIG. 278

Urethrosopes in use by the author. From above downward: 1 Female operating; 2 Joly's operating; 3 Joly's examining; 4 Child's operating urethroscope (Charnière 16).

which the surgeon faces from the sitting position. The urinary meatus is exposed by inserting the second and index fingers between the labia minora and then separating them. The appearances at the meatus should be noted: discharge, redness, stenosis, eversion of edges, prolapse of urethral mucosa or other abnormal phenomena will be at once apparent.

**Palpation**—This is made along the anterior vaginal wall in the mid line and will reveal tenderness or thickening in the course of the urethra.

**Instrumentation**—Much important information can be gained about the urethra by this means. A size 24 Charnière bougie should lie in the urethra without gripping; it should cause neither pain nor bleeding when passed gently and skilfully. Tenderness or bleeding generally indicates inflammation.

Failure of this instrument to enter the meatus or to pass along the lumen without being gripped indicates a contraction either localized or general.

**Urethroscopy**—A perfect view of the whole mucous surface is to be obtained by using an irrigating urethroscope with direct vision through a terminal window (Fig. 228).

The longitudinal folds of the urethral mucosa are obliterated by the gentle pressure of the inflowing current provided that the outlet tap is turned off.

Gentle manipulation of the inner end of the instrument will soon determine whether any prominences are normal or not.

A satisfactory view is also generally obtained through an instrument with a foroblique lens system.

## CONGENITAL MALFORMATION (see p. 38)

### PROLAPSE

By this is meant an extrusion of urethral mucous membrane through the external urinary meatus. The condition may be partial in the sense that only a portion of the circumference protrudes or it may be complete when the whole is involved.

**Ætiology**—The condition is met with in the young and the old. The causes are not always clear but long continued straining with micturition, defecation or labour plays its part. From the last cause there is an additional factor namely the weakening of the support for the floor of the urethra which occurs when there is any degree of vesicovaginal displacement. An angiomatic state of the urethral mucosa is sometimes an associated condition.

**Pathological anatomy**—Partial prolapse is the commoner condition and involves principally the floor of the urethra from which the mucous membrane becomes separated from the muscular coat and thus is able to protrude from the external urinary meatus. In due course the epithelial covering of the protruding portion becomes squamous in type.

The blood supply in the underlying connective tissue tends to increase as vessels become more numerous and larger and in the course of time increased vascularity also occurs in the overlying mucous membrane.

**Symptoms and signs**—Frequency of micturition in some degree is fairly constant, dysuria is intermittent. In proportion to the degree of prolapse there is a sense of local soreness and discomfort especially on movement.

Sometimes the protruding mass bleeds especially on walking. Attacks of cystitis tend to occur as the condition advances.

On inspection in the mildest cases there is simply a small zone of the mucosa of the urethral floor projecting from the meatus. In more advanced cases the projection is in the form of a pedunculated mass pink or red in colour often obviously highly vascular which tends to bleed when touched and above which the urethral orifice is discovered by using a probe.

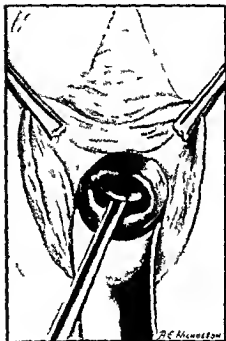
When the prolapse is complete the urethral orifice can be found in the middle of the projection and by running a probe round the periphery a furrow is detected which marks the reflection of the mucosa from the urethral wall on to the prolapse.

**Diagnosis**—The condition has to be distinguished from caruncles and angiomas which occur in the neighbourhood of the meatus. A caruncle has a narrow pedicle and is darker in colour than a prolapse. The increased vascularity present in some cases might make the discrimination from an angioma difficult but if there is an orifice in the midst of the mass the diagnosis

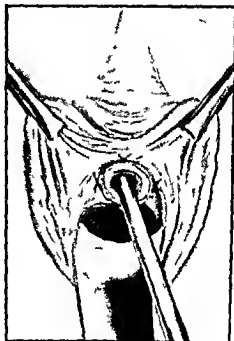


will be clear. A rare condition calling for care in diagnosis is the presentation through the external urinary meatus of a ureterocele—a cystic dilatation which arises in connection with a ureteric orifice. The important points indicating a ureterocele are: a probe can be passed alongside the mass into the bladder; it can be moved in a complete circle round the mass without encountering an obstruction; the mass can be reduced into the bladder; the absence of the urethral orifice from its summit.

**Treatment**—Where there is any existing cause for straining this must be dealt with. In bad cases, whether the prolapse is partial or complete, a local excision of the prolapsing mucosa should be carried out and the cut edges



A



B

FIG. 229

A Prolapsed urethra in a woman aged 75

B Appearance immediately after excision of prolapse

re sutured with catgut. In carrying out this procedure in a case of complete prolapse the following technique is satisfactory. From the outer surface the whole thickness of the urethral wall is transfixed by four chromic catgut sutures placed equidistantly round the circumference (Fig. 229). The sutures are inserted as far back from the meatus as possible and at right angles to the long axis of the channel. After tying these the redundant mucosa is put on the stretch with four evenly spaced pairs of forceps and then shorn off about  $\frac{1}{4}$  in in front of the suture line. The edges of the skin and mucous membrane are then adjusted by interrupted catgut sutures. An alternative method is to split the mass from top to bottom into two halves and to cut away each half back to the level of the meatus and then to suture the adjacent cut edges with catgut.

For mild cases a linear groove or more than one in the long axis of the mucosa should be made with a coagulating current. The ultimate contraction of scar tissue resulting from this procedure will obliterate or reduce the prolapse.

**Pathological anatomy**—A diverticulum may occur as a localized sac lying between the urethra and the anterior vaginal wall or it may exist as simply a dilated portion of the urethra

When it occurs as a sac its diameter may vary from a small fraction of an inch to several inches. The orifice by which it communicates with the urethra may be wide or narrow

The nature of the wall of the urethrocele varies according to its origin. There are generally some muscle fibres scattered amongst the fibrous tissue of which the wall of the sac is chiefly constituted. An abundant supply of venules dispersed through the fibrous tissue is a common feature. The sac is likely to be lined by the same type of stratified epithelium as the part of the urethra with which the sac communicates, or if suppuration is present there may be a complete absence of epithelium, which is replaced by granulation tissue or necrotic areas

The contents of the sac are urine, pus and often calculi

**Symptoms, signs and diagnosis**—In some cases there are no symptoms of importance, but more often there is increased frequency, with some scalding during and after micturition, attacks of acute cystitis are liable to supervene from time to time

On inspection a swelling is apparent in the line of the urethra, this is confirmed by palpation. As a rule it is a characteristic of the swelling that it is reduced in size by pressure, while at the same time purulent fluid appears at the meatus

Palpation over a sound gives precise information concerning the relationship of the swelling to the urethra. The beak of a curved metal instrument if kept closely to the urethral floor can sometimes be made to enter the sac where it can be felt by palpation. A second instrument passed at the same time into the bladder makes it clear that the first one has not entered a cystocele

**Treatment**—A sac which is lined with mucous membrane should be extirpated by careful dissection. After passing a catheter into the urethra to safeguard this channel a longitudinal mid line incision is made over the swelling, and the sac is carefully dissected out. The opening into the urethra is obliterated by three layers of interrupted chromic catgut sutures. Using fine gut the first line unites the edges of the mucous membrane. The needle is inserted so that the knots will lie in the urethra. The next layer of sutures includes the tissues between the vaginal and urethral mucosæ, and is inserted in Lembert fashion. Finally the vaginal wall is closed by vertical mattress sutures using strong gut

If sepsis is present the sac must first be widely incised and drained, and the excision of the sac and repair of the urethra left to a later date

It is better to gently pass a sound from time to time than to make use of an indwelling catheter

## INFLAMMATION (see p 629)

### CARUNCLE

**Ætiology**—Chronic inflammation is commonly present in the urethra and in the new formation itself, these facts suggest that the caruncle has an inflammatory rather than a neoplastic origin, its high degree of vascularity is to be explained by a similar state of the urethral submucous tissue from which it springs

**Pathological anatomy**—The mass is a pedunculated protrusion which takes its origin from the floor of the female urethra near the external meatus. Microscopically it is found to consist of a highly vascularized connective tissue stroma which is diffusely infiltrated with polymorph leucocytes. It is covered with squamous epithelium.

**Symptoms, signs and diagnosis**—The condition causes pain which is often present at all times and which is aggravated by movement and micturition. Hematuria, a blood stained urethral discharge and frequent and difficult micturition are all symptoms which are commonly met with.



FIG. 230

Urethroscopic view of polypus in the posterior urethra of a woman.



FIG. 231

Urethroscopic view of a cyst of the posterior urethra of a woman, aged 38, who suffered from frequency and urgency which amounted to incontinence.

On inspection a small red mass is seen projecting from the external meatus. On inserting a probe it is not difficult to ascertain that it is soft, pedunculated and attached to the floor of the urethra.

**Treatment**—The most satisfactory method of eradication is by fulguration using only a light current. It may be possible to do this by retracting the edges of the meatus so that the base of the pedicle is exposed to which the electrode is then applied. If such an exposure cannot be made the fulguration should be applied through an operating urethroscope. Excision with the knife is not so satisfactory if there is difficulty in exposing the base of the pedicle. Recurrence is common if removal is not complete.

### POLYPI

Routine urethroscopy in women reveals the fact that polypi are not uncommon.

**Ætiology**—They are commonly associated with chronic inflammation of the urethra and may be regarded as of inflammatory origin.

**Pathological anatomy**—They are frequently multiple and are generally situated at any point of the circumference near the internal meatus (fig. 230). They are often associated with similar projections into the bladder from the internal meatus and almost invariably associated with trigonitis (urethro trigonitis). (See also Urethroscopy and Cystoscopy below.)

Lesser degrees of these urethral projections may be referred to as hillocks (Fig 346)

**Symptoms, signs and diagnosis**—Both degrees of the change are commonly associated with chronic disturbances of micturition chiefly in the form of increased frequency. Some cases suffer from aching in the vulval urethral pubic inguinal and sacral regions. Many of the cases are also subject to attacks of cysto-pyelitis. Some suffer from chronic discomfort in the renal regions. The intravenous urograms tend to show mild dilatation of one renal pelvis or of both renal pelves.

**URETHROSCOPY** is the only certain way of knowing whether any of these projections exists. Each is commonly seen as a single finger like process tapering towards its free extremity, pale in colour with a blood vessel coursing through its long axis. Generally adjacent areas of inflammation can be noted. Sometimes several processes spring from a single base. The above features distinguish it from a caruncle which is red, highly vascular and has a club shaped free extremity.

**THE CYSTOSCOPIC APPEARANCES** commonly show no more than early chronic inflammatory changes on the front of the trigone and sometimes of the internal urinary meatus—urethro trigonitis and urethro cervico trigonitis.

**Treatment**—All well marked cases will be benefited by light fulguration to the polyp. Only the weakest coagulating current should be used. This will be found completely adequate. Strong currents are not only unnecessary but dangerous.

### CYSTS

These are said to be due to the blocked ducts of glands but sometimes they occur in the posterior urethra in connection with adventitious glandular structures which are not supplied with ducts (Fig 231). They are easy to destroy by fulguration. Only the minimum strength of current should be used for this purpose in order to avoid the danger of scar tissue and stenosis.

### STRICTURE

**Ætiology**—Although this condition is not common in women it is by no means rare. The causes are inflammation, trauma, congenital tuberculosis or syphilis.

**THE INFLAMMATORY CAUSE** is not necessarily gonorrhœa. Non specific inflammation certainly provides a proportion of cases. **TRAUMA** is a more important factor in the female than in the male because of **OBSTETRIC** complications arising from injury to the urethra from pressure of the foetal head or the application of instruments during delivery. Ulceration from the presence of **FOREIGN BODIES** in the urethra is a cause which has to be considered from time to time. In many cases the origin of the stricture is obscure, some are undoubtedly the result of a simple inflammatory process.

**Pathological anatomy**—**CONGENITAL STRICTURE** may occur in any portion of the channel and is frequently associated with other developmental abnormalities of the urinary tract. **INFLAMMATORY STRICTURE** occurs most commonly at or in the vicinity of the external meatus. **OBSTETRICAL STRICTURE** is more commonly seated in the middle or posterior part of the urethra. Annular and bridal strictures are the common forms in which the obstruction occurs.

result of these measures. Improvement in symptoms from treatment when the condition is part of a generalized fibrosis involving the vulvæ and vagina may be difficult to obtain.

### URETHRAL CALCULI (see p 901)

### URETHRAL FISTULÆ

In women these open either on to the vestibule or into the vagina.

**Ætiology—OBSTETRIC CAUSES**—These provide the majority of the cases and are due to either prolonged pressure of the foetal head on the urethra or injury from instrumentation at the time of delivery.

**FOREIGN BODY**—The presence of one of these in the urethra for a prolonged period results in ulceration and may quite easily lead to fistula.

**PERIURETHRAL ABSCESS**—This may be consequent upon gonorrhœa, simple infection of the urethral glands, infection of a urethral diverticulum or urethral stricture.

**TUBERCULOSIS**—This is an unusual cause of urethral infection but does occur and has given rise to fistula.

**SYPHILIS**—The destruction caused by this type of ulceration involving the urethra leads to fistula.

**MALIGNANT GROWTHS**—When these occur in the urethra they generally result in fistula.

**Pathological anatomy**—The track of the fistula is of necessity a short one. The opening at either end may be narrow but the condition is generally seen as a considerable gap in the under aspect of the urethra; there may even be total destruction of the urethral floor.

Obstetric fistulae are generally associated with a good deal of scar tissue in the surrounding parts.

**Symptoms, signs and diagnosis**—When the fistula is narrow there may be the escape of only an occasional drop of urine during micturition with little or no inconvenience.

In the presence of a marked urethral deficiency complete incontinence of urine is likely to be the result. Fistulae associated with urethral stricture are generally accompanied by a considerable degree of incontinence of urine.

In order to ascertain the true state of affairs the patient should be examined on a urological chair in the presence of a good light.

**Treatment—WHEN THE FISTULA IS NARROW**—The track should be excised and the opening into the urethra closed in the manner described under Treatment of Urethrocele (see p 421).

**WHEN THERE IS A POCKET IN THE FISTULOUS TRACK**—The sac must first be opened and thoroughly drained and no attempt at repair must be made until signs of infection have all disappeared. As a rule a period of at least three months should elapse before the plastic procedure is undertaken.

**EXTENSIVE URETHRAL DEFICIENCY WITH INCONTINENCE**—Marion (1935) recommends closing the bladder below and reconstructing a new urethra.

Diversion of the urinary stream by suprapubic cystostomy may be tried if this fails to keep the patient dry; then the more drastic procedures of implantation of the ureters into the bowel or bilateral nephrostomy and occlusion of ureters may justifiably be considered.

FISTULA FROM NEOPLASM may require suprapubic cystostomy.

will generally complain first of irritation about the vulva the other symptoms appearing later in due course

Inspection in the deeply seated type may reveal some swelling of the anterior vaginal wall along the line of the urethra Palpation of the urethra will certainly reveal a firm perimeurethral swelling Instrumentation of the urethra produces bleeding at once Urethroscopy is likely to be unsatisfactory because of the readiness of the growth to bleed

In the urethro vaginal type the diagnosis is obvious as soon as the vulva are fully exposed Irregular ulceration and projecting masses which are hard and bleed readily when touched are seen in the vicinity of the urinary meatus

As a rule there is no difficulty in deciding at once between a simple and a malignant condition but a biopsy when possible will settle the question

TREATMENT—Operative treatment demands the removal of the whole urethra If this is undertaken the neck of the bladder should be closed and permanent suprapubic cystostomy established

It is better however to attempt a cure by the implantation of radium needles In an early case the prospects from this line of treatment are not unfavourable Suprapubic cystostomy should be undertaken as a preliminary It will be necessary to maintain this form of drainage permanently or to implant the ureters into the bowel if the application of radium results in complete obliteration of the urethra alternatively it may be possible to re-establish micturition as a result of instrumentation

**Adenocarcinoma**—This arises in the glands which drain into the urethra It tends to occur in women of somewhat younger age than those who are attacked with epithelioma of the urethra

**Sarcoma**—Tumours of this nature are also rare and when they do occur arise from the vicinity of the external meatus They may be sessile or pedunculated hard or soft The real nature of such a mass can only be determined by histological examination

The local application of radium is the only treatment which offers any prospect of help but the prognosis is always bad

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## CHAPTER XXXVI

### THE PROSTATE

#### SURGICAL ANATOMY

**GENERAL DESCRIPTION**—This organ is shaped like an inverted cone, or pyramid, with its base upwards and its vertex downwards. It is composed partly of smooth muscle fibres, partly of strands of fibrous tissue and partly of glandular substance. The muscle provides a sheath with strands penetrating the substance of the organ and forming a meshwork within which the glandular elements are situated. The whole is enclosed within a well marked fibrous investment derived from the pelvic fascia and from which a few fibrous strands form a loose irregular network within the organ but do not divide it into any distinct sections.

In adult life the gland is divided into three main parts—two lateral lobes and a posterior lobe forming that portion of the organ which projects backwards towards the rectum.

The gland is of firm consistency and in health measures from 1 to  $1\frac{1}{2}$  in transversely at its base and about  $\frac{3}{4}$  in from base to apex. It presents a base and three external surfaces of which the base is intimately interwoven with the vesical base, the junction between the two being marked by a pronounced groove. The posterior surface is roughly triangular, looks downwards and backwards and is separated from the rectum by a well defined sheet of fascia known as Denonvilliers' fascia. The two lateral surfaces face outwards and are in relation to the pelvic fascia covering the inner surfaces of the anterior portions of the levatores ani muscles. The apex points downwards and touches the deep triangular ligament at a point where a line passes when drawn from the lower border of the symphysis pubis to the tip of the coccyx.

If the bladder be opened by a mid line incision and a finger is passed through it into the internal meatus the finger will be surrounded by the prostate. Again a finger in the rectum directed towards its anterior wall will meet the prostate about 2 to  $2\frac{1}{2}$  in within the anus. The organ is therefore, well protected from all the usual forms of trauma.

Certain structures near the prostate must be noted and their position defined. The posterior surface lies directly against the anterior rectal wall from which however it is separated by the two layers of Denonvilliers' fascia. The urethra enters the superior or vesical surface of the organ near its centre and for most of its course is situated rather nearer the posterior than the anterior limit of the gland. It curves slightly forwards to arrive at the anterior aspect near the apex where it passes through the deep layer of the triangular ligament and becomes the membranous urethra.

In the groove between the posterior surfaces of the bladder and of the prostate the terminations of the vasa deferentia and vesiculæ seminales unite to form the common ejaculatory ducts which, piercing the prostatic substance at this site, approach each other and terminate at openings in the verumontanum on the floor of the prostatic urethra. In this manner a triangular portion of the upper posterior part of the prostate is delimited anatomically and has been termed the "middle lobe," a region prone to senile enlargement. The

*verumontanum* is important in urethroscopic examinations of the prostate as its appearance frequently indicates underlying disease, and it is a valuable landmark in estimating local urethral distortions. It also defines the "prostatic sinuses," which are two depressions one on each side of the centrally placed *verumontanum*. The prostatic ducts open into these sinuses and convey prostatic secretion into the urethra. Apart from these there are few glandular openings but a small number open into the remaining areas of the floor of the urethra and still fewer into the roof of the canal in front.

**Attachments**—If it is remembered that the parietal pelvic fascia which lines the pelvis gives off a visceral or transverse diaphragm to close the pelvic outlet the description of the fascial connections of the prostate becomes comparatively easy to follow. As the various pelvic structures pass through this transverse membrane they receive fascial investments of varying thickness and the prostate acquires its well-defined fascial sheath in this manner and in health is permitted a fair degree of mobility thereby.

Outside the prostatic sheath in front, the visceral layer of the pelvic fascia passes forwards from the prostatic fibrous capsule to the parietal layer behind the pubes and presents two lateral thickenings known as the pubo prostatic ligaments. This structure has also been called the anterior vesical ligament. The space between the anterior wall of the bladder and the posterior surface of the pubic symphysis, lying above the anterior vesical ligament, is known as the Space of Retzius. Posteriorly the fascial investment of the prostate blends with that surrounding the rectum and is known as Denonvilliers' fascia, which is important during the perineal approach to the organ. Laterally the visceral layer on the sides of the prostate is connected with the fasciæ covering the levator ani muscles.

The peritoneal cavity lies an inch or so above the upper posterior border of the prostate and has no direct contact with it.

**Blood supply**—This is mainly derived from the inferior vesical arteries, with a few twigs from the middle hæmorrhoidal and the internal pudic arteries. There is no single arterial supply but a number of small vessels reach the substance of the organ of which two noteworthy groups enter one on each side by way of the posterior aspect of the groove between the bladder and prostate. These are apt to cause bleeding during prostatectomy in the posterior edge of the torn internal meatus.

Immediately within the fibrous prostatic capsule is a considerable venous plexus which is most marked in the groove between the prostate and the bladder (the Plexus of Santorini). It drains the prostate and receives the two dorsal veins of the penis just behind the symphysis pubis together with tributaries from the vesiculæ seminales and the vasa deferentia.

**Lymphatic drainage**—The lymphatics of the prostate run upwards over the vesical base into the glands situated along both external and internal iliac arteries and also into those lying in the sacral hollow (Fig. 232).

**Nerve supply**—In relation to the external aspect of the lateral lobes, between them and the levatores ani muscles, is a marked plexus of sympathetic nerves which is derived from the hypogastric sympathetic plexus, originating from the roots of the tenth, eleventh and twelfth dorsal, the fifth lumbar and the third sacral spinal nerves, and which is distributed to the prostate.

## EXAMINATION OF THE PROSTATE

**Local and general investigation**—After carefully noting the medical history of the patient, the degree of frequency of micturition, the nature of any pain,



local or referred and the presence or absence of hæmaturia, the rate of flow and the size of the stream of urine should be carefully observed in order to estimate the propulsive force of the bladder or the amount of urethral obstruction. Any hesitation, dribbling or sluggishness of the urinary stream or the presence of incontinence must be carefully analysed.

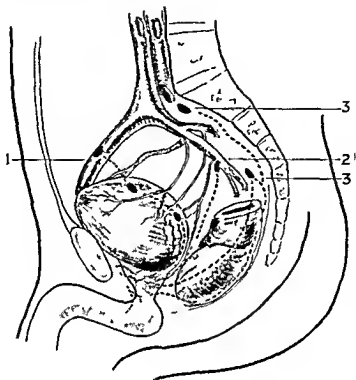


FIG 232

Diagram to show lymphatics of prostate 1 External iliac chain 2 Internal iliac chain 3 Sacral glands

The first examination is that of the patient's urine, and the well known 'two glass test' is always useful at the primary investigation because by this means inflammations of the anterior urethra may be excluded and other information elicited. The urine should be inspected macroscopically for pus, flakes of epithelium, mucous, prostatic 'threads' or 'plugs,' and, if necessary, this inspection should be repeated as soon as possible after prostatic massage. The presence or absence of blood must be carefully noted and a detailed microscopic examination of the urine must also be made. A normal urine centrifuged and examined microscopically, will reveal a few lecithin bodies, a small number of epithelial cells and a sprinkling of degenerate leucocytes (pus cells). Any inflammation of the prostatic urethra will increase enormously the number of pus and epithelial cells and account for the presence of unusual debris. The bacteriological picture may also be determined from an aseptically collected specimen. The presence or absence of red blood cells is important, a few in each microscopic field especially after catheterization, may be of no account but if persistent in any numbers their origin must be carefully sought for. The presence or absence of casts etc. must also be noted.

The urine must be examined chemically for albumen, sugar, the amount

of urea its specific gravity and any excess of phosphates carbonates oxalates urates or of uric acid

In every investigation it should be remembered that whilst positive determinations are valuable negative findings are often of doubtful significance and the observations should be repeated as often as necessary to establish the true condition

After these preliminaries the abdomen of the patient should receive careful attention By palpation and percussion it is possible except in the obese to determine whether there is any marked vesical distension after micturition and in this manner any pronounced degree of residual urine can be demonstrated Also enlargements and misplacements of the kidneys should be sought for as well as any other abdominal abnormality

It is however upon rectal examination that most information about the prostate is obtained The best posture for the patient during this proceeding is the knee elbow position with the knees slightly separated the dorsal spine hollowed forwards and with the examiner's left hand supporting the lower abdomen just above the pubes By this means the prostate is easily reached and explored by the examining finger If for any reason the knee elbow position cannot be adopted it is best for the patient to lie on his side with the knees well flexed

Before the introduction of the finger into the rectum the state of the anus and perineum should be inspected for fissures sinuses or hæmorrhoids and within the rectum polypi strictures or neoplasms may be met with and may need attention to provide a satisfactory solution of the patient's complaints

Next the examining finger investigates the rectal aspect of the prostate itself It is identified as a low lying elevation in the anterior wall of the rectum about 2 to 2½ in within the anal orifice it is of firm consistency with a shallow groove at each of its lateral edges and also a wide shallow central furrow Its upper horizontal limit can also be easily felt The healthy organ can be moved from side to side and up and down to a limited extent The above points should be carefully checked and the size of the gland indurations irregularities soft patches obliterations of the central or lateral furrows and any loss of mobility should be carefully noted The two seminal vesicles should also be sought for and their condition recorded Masses of induration extending from the prostate to the pelvic walls must be defined being due to infiltration by neoplastic or inflammatory products Pressure on the prostate may reveal the presence of deep nodules tender spots etc and a sensation of crepitus may suggest the presence of calculi

**Special examinations**—If the diagnosis remains uncertain special investigations are called for These are of an instrumental nature and must be conducted with extreme care because whilst the healthy urethra will submit to a deal of manipulation by instruments the presence of any local pathological lesion makes bacterial invasion all too easy Trauma should be avoided by extreme gentleness during every instrumentation and strict cleanliness with a rigid antibacterial technique is essential

Cystoscopy is the first special investigation and by its means the state of the bladder is seen to be either healthy congested or inflamed the vesical muscle may be either smooth and normal or hypertrophied as revealed by pronounced submucosal strands (trabeculation) The state of the ureteric orifices the trigone and the shape of the internal vesical meatus should all be observed The internal meatus may reveal posterior slipping due to intravesical prostatic protrusion instead of a smooth transition from the trigone into the posterior urethra This may denote swelling of the internal

meatus or the protrusion of an enlarged middle prostatic lobe into the bladder. Intravesical protrusion of the lateral lobes may also be seen with perhaps an inverted V shaped gap at the anterior aspect of the meatus between the two projecting lateral lobes.

**POSTERIOR URETHROSCOPY**—By this investigation which is complementary to cystoscopy much additional information can be gained the appearance of the posterior urethral mucosa the degree of mobility of the urethral walls as tested by varying the pressure of the irrigating fluid will reveal much as to the condition of the underlying prostate and the presence of dilated prostatic ducts sometimes with escaping pus or protruding calculi will yield further information. The amount of intravesical prostatic protrusion can be estimated when investigating a case of simple prostatic enlargement and neoplastic growths may be discovered.

**RADIOGRAPHIC EXAMINATION**—A simple X ray photograph may show the presence of calculi in the prostate and contribute towards the correct assessment of the precise condition afflicting the patient. Also by observing the amount of any filling defect in a cystogram the degree of the intravesical prostatic enlargement may sometimes be determined and may be useful when intra urethral manipulations are contraindicated or impossible.

**NEEDLING**—The passing of a long hollow needle from the perineum into the substance of the prostate under the guidance of a finger placed in the rectum has been advocated in America and elsewhere. Powerful aspiration is made on the needle by a syringe in order to obtain specimens for microscopic examination and in this manner the presence of identifiable bacteria pus and neoplastic cells may be revealed.

### CONGENITAL MALFORMATIONS

The prostate is derived from five embryological buds one anterior two lateral and two posterior. Of these the anterior bud fails to develop as a gland and becomes the anterior commissure of smooth muscle and fibrous tissue uniting the two anterior aspects of the lateral lobes and containing but few mucous elements. One posterior bud just outside the internal urinary meatus remains rudimentary and gives rise to a few submucous glands in adult life. The main organ is derived from the remaining three lobes.

Variations in the prostatic development described above produce a variety of malformations in the fully formed gland. Cases are on record of complete absence of the prostate due to a failure of development of all the original elements or one lateral lobe may be missing and give rise to a unilateral prostate and occasionally some glandular development occurs in the anterior lobe giving rise to gland substance in front of the urethra or to an anterior lobe. Most of these occurrences are rare and the knowledge of them is derived from carefully conducted post mortem examinations.

Secretion from the prostatic lobes is conveyed into the urethra by ducts. Those from the rudimentary mucoid elements in the anterior commissure and of the inner posterior part of the gland are short and straight whilst the ducts of the main posterior lobe are longer and those of the lateral lobes longest of all. Both the latter sets of ducts curve round the urethra to enter the floor of the canal in the prostatic sinuses.

Congenital cysts of the prostate due to prenatal obstruction of the ducts occur from time to time. They may be single or multiple may be situated directly under the mucosa of the prostatic urethra or deeper in the glandular substance. They are sometimes large enough to cause obstruction to the outflow of urine.

The obstructive type is seen occasionally in post mortem examinations on infants or on still born children and is frequently found associated with other congenital abnormalities of the genito urinary tract. Occasionally owing to defective development of the termination of the Mullerian ducts in the embryo their vestigial fused opening into the urethra known as the sinus pocularis may become sealed off and cause a cyst in the verumontanum. From the same cause obstruction to the urethra may occur. Sometimes a single large sac opens into the sinus pocularis (Fig. 233) this is a vestigial vagina.



Fig. 233

The lower of the two medially placed shadows demonstrates a prostatic pouch which has been filled with opaque medium after inserting a ureteric catheter. The upper shadow is a cystogram. The patient (aged 47) also had a congenital deformity of the spine. (Mr. Hunsbury White's case.)

#### ATONY OF THE PROSTATE

Some middle aged men suffer from a train of symptoms which has been studied and described by certain authorities notably by Marion (1935). The condition is attributable to a local nervous depletion and may be more common than is usually supposed. The symptoms vary from mild discomfort to considerable pain, there is more or less sexual impotence and a false spermatorrhœa which may lead to a definite sexual neurasthenia the patient becoming a martyr to a variety of fears and apprehensions such as of impending cancer or complete impotence and sterility. Much of this trouble is of a functional

type but as so frequently happens there is just that basis of reality which may prolong the symptoms indefinitely. If allowed to progress the neurasthenic state becomes predominant and if the nervous exhaustion remains unchecked the patient may become almost a mental and physical wreck and may often be extremely difficult to handle.

These patients complain of pain in the perineum, scrotum and penis and have a variety of sensations in the neighbouring organs noticeably in the region of the anus and rectum which may be slight or definitely painful. Clinically such cases are often mistaken for chronic prostatitis and may be subjected to long courses of rectal massage, diathermy etc. which still further fixes the mental attention on the prostatic region.

The first point which should strike the observer is that the urine is clear sparkling and devoid of pathogenic bodies and this alone should suggest that the complaint is not of inflammatory origin. In addition it may be noticed that there is a diminution of the urinary stream owing to a loss of tone of the detrusor muscle of the bladder, no demonstrable obstruction to the outflow being discovered either by the passage of sounds or by endoscopic inspection. This loss of pelvic tone affecting the bladder and prostate and the functional train of symptoms which follow it often cause partial or complete impotence during the course of the illness. The prostate also becomes distended by its own secretion and the act of defecation may squeeze out a quantity of clear watery exudate. This latter symptom distresses the victim still more because he imagines that he is suffering from loss of spermatic fluid.

The diagnosis is based on the age of the patient—which is below that of prostatic enlargement—the diminution of the stream of urine on micturition and on rectal examination which reveals a large soft flabby prostate perhaps of considerable size. Pressure upon it easily expresses a clear watery discharge which appears at the external urinary meatus and should never be mistaken for either true spermatic fluid or for pus which has a slightly yellow tinge. The microscope will also immediately distinguish them from each other. It will be noticed too that although the prostate is enlarged it still retains its characteristic shape is not indurated and does not lose its median furrow. Further there is no urinary obstruction and the urine is normal and not infected.

Treatment should largely be directed to reassuring the patient and to removing his introspective fears. Local manipulations should therefore be avoided, a regular healthy régime advised with plenty of good non-irritating food and the nervous system should be assisted by nerve stimulants and tonics. Marion advises the use of arsenical preparations for this purpose. The reassurance and the removal of apprehensions will often cause immediate improvement and may alone lead to a cure but when the neurasthenic tendency is fully established it may be extremely difficult to eradicate the unhealthy warp in the patient's mind and until this can be done the trouble is apt to continue. Such cases are sometimes extremely difficult to deal with.

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**Age incidence**—It is estimated that something like 35 per cent of men over 60 years of age suffer from enlarged prostate. It is generally held that it is uncommon till after 50 but this belief has been challenged recently by Thevenard (1940) who claims that it is relatively frequent under 40 and can be detected by urethroscopic examination though the prostate is normal on rectal examination and the patient free from symptoms. Lowsley (1941) supports this view and found in 250 post mortems 23.4 per cent of men over 30 to have enlargement of the subcervical group of glands.

**Race**—It is most common in Europe and North America—though less common amongst the negroes. In the peoples of India it is fairly common but is rarely found in the Mongolian races.

### PATHOLOGICAL ANATOMY

As the prostate enlarges it does so inside the gland proper and as it continues to grow it thins out and expands the latter so that the gland itself



FIG. 235  
Diagrammatic representation of  
normal prostate

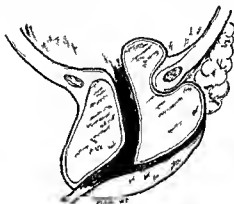


FIG. 236  
Diagrammatic representation of enlarged  
prostate

comes to form a sheath surrounding the enlarged prostate. At operation the enlarged prostate is enucleated inside this glandular sheath which remains behind. As enlargement of the prostate takes place its projection may be detected in two main directions—below where its size may be gauged by rectal examination and above where it projects into the bladder and can be seen on cystoscopy. The earliest enlargements are intravesical and so diagnosed by cystoscopy. The normal prostate varies in size; its average weight is  $4\frac{1}{2}$  gm, the average weight of enlarged ones removed by operation is 1 to 3 oz. and rarely exceeds 6 to 8 oz. though larger ones up to 16 to 18 oz. have been recorded. The enlargement commonly affects both lateral lobes equally though one may be considerably larger than the other. The middle lobe enlargement is generally held to be an extension from one or other lateral lobe—and there certainly is no septum separating this lobe from the lateral lobes—though there is a certain amount of embryological evidence to suggest the possibility of a true median lobe. Thomson Walker (1904) demonstrated that generally the enlargement of the prostate was confined to the part of the prostate above the level of the verumontanum and ejaculatory ducts, all of which remain fixed—the ejaculatory ducts are below and not embedded in the hypertrophied

mass (Figs 235 and 236) As it enlarges extravasically and extends backwards beneath the base of the bladder it strips the seminal vesicles from the bladder so that they come to lie behind rather than above the gland (Figs 237 and 238) As it enlarges intravesically it insinuates itself within the ring of the vesical sphincter which becomes stretched and thinned out over the intravesical projection the sphincter eventually ceases to function and control is maintained by the compressor urethræ muscle When the intravesical projection is more or less equal all the way round it forms a collar like projection—the so called intravesical collar—round the sides and back of the internal meatus This intravesical projection may be very irregular however one lobe projecting more than the other or it may be confined almost to the middle lobe which is formed probably by a portion of the enlarging prostate insinuating itself between the longitudinal muscle fibres which form the superficial layer of the trigone and thence become continuous with the longitudinal muscular layer of the urethra

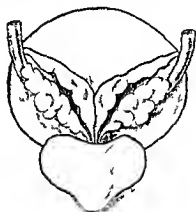


FIG 237  
Diagram showing rectal aspect of  
normal prostate

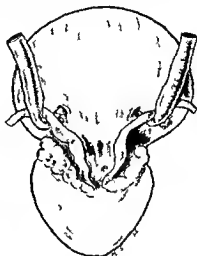


FIG 238  
Diagram showing rectal aspect of  
enlarged prostate

On microscopy the enlarged prostate consists of gland tubules in a connective tissue stroma the relative proportion of these two varies in the larger soft prostates the stroma is least in evidence whereas a more prominent stroma is found in the small fibrous prostate The stroma may contain some unstriped muscle fibre and when the urine is infected round celled infiltration may be found The tubules lined with columnar epithelium are for the most part dilated and branched With extensive dilatation small cysts are formed in which the epithelium becomes flattened The lumina contain epithelial debris large granular and fatty cells and corpora amylacea

**Changes in the urethra.**—The enlarged prostate effects changes in the posterior urethra bladder ureters and kidneys As the enlarging gland projects into the bladder beneath the mucous membrane the vesical orifice becomes raised so that the portion of posterior urethra behind the veru montanum becomes lengthened and some idea of the size of the prostate is obtained by noting the length of catheter required It also becomes compressed laterally by enlargement of the lateral lobes or posteriorly by a middle



lobe enlargement With unequal enlargement of the different lobes it may be distorted considerably commonly an antero posterior angle is formed at the level of the verumontanum producing a valve which tends to close with the increased intravesical pressure during micturition

**Changes in the bladder, ureters and kidneys**—At first with increasing obstruction the musculature of the bladder undergoes hypertrophy and the bladder wall becomes thickened but as the residuum increases the walls become stretched and the bladder capacity increased Viewed from the interior it is seen to be trabeculated i.e. the hypertrophied muscle bundles stand out prominently and the mucous membrane is pouched or herniated between them in this way a large diverticulum or diverticula may be formed With the elevation of the bladder base and increased intravesical pressure the post prostatic pouch develops and as this cannot be emptied by the bladder contractions it contains stagnant urine the predisposing factor in stone formation and infection

The kidneys and ureters show a similar picture of hypertrophy and dilatation The kidney substance becomes fibrotic and the subject of chronic interstitial nephritis and later with the advent of sepsis pyelonephritis acute or chronic supervenes The cause of obstruction with the gradual development of residual urine and retention is difficult to explain The outstanding fact is that the size of the prostate bears no relation to the amount of obstruction produced e.g. with considerable enlargement of the lateral lobes only there may be no residual urine whereas a very small projection of the middle lobe may result in complete retention The original explanation that retention was due to fatigue and atrophy of the bladder musculature is negated by the fact that after prostatectomy the patient can empty his bladder again It is easy to see how a valvular obstruction is produced by angulation of the posterior urethra or by a middle lobe ball valving the internal meatus but this does not explain the mechanism of all enlargements There may be some dynamic or neuromuscular explanation which still eludes solution thus Joly (1923) seeks an explanation in the ordinary laws of hydrostatics the intravesical pressure during micturition acts downwards towards the urethra this pressure can be resolved into horizontal and vertical components The former acts on the intravesical projection of the prostate and closes this portion of prostatic urethra in the same manner as an encircling elastic band This however does not explain retention when there is little or no intravesical projection The final factors in precipitating an acute retention in a patient with an enlarged prostate are congestion and spasm the sequelæ often of a chill constipation or over indulgence in alcohol

### SYMPTOMS AND SIGNS

Two main clinical types are met with the former is characterized by irritation of the bladder and frequency of micturition out of proportion to the amount of obstruction or residual urine the latter type by the development of a slow chronic symptomless retention progressing to an overflow incontinence The latter may be the first indication to the patient that something is wrong As a rule the first symptom is frequency of micturition it occurs both day and night though nocturnal frequency is the patient's chief complaint He sleeps undisturbed through the early hours up to 2 or 3 a.m. after which he may have to get up several times to pass urine The next symptom is some degree of difficulty in micturition and obstruction to the urinary stream In the early stages the difficulty may amount only to some hesitation, or a slight latent

period before the flow begins difficulty is apt to occur especially when the patient has held his urine too long. The stream loses its force is slower and tends to dribble towards the end. It may be urgent or precipitate so that unless he relieves himself at once he may lose a little urine involuntarily. The stream may be intermittent the patient passes all he can at the moment but in a short time has to pass more. In some cases micturition can be accomplished only when sitting at stool or in the knee elbow or some other abnormal position.

Pain is not a prominent feature of simple enlargement and when present portends some complication such as cystitis or stone. The patient is unable to empty his bladder and an increasing amount of residual urine remains. This progresses until an acute complete or chronic retention supervenes the former is accompanied by acute pain from spasmodic efforts of the bladder to empty itself the latter may be painless and eventually if unrelieved ends in verflow and incontinence of urine (passive incontinence).

A first attack of acute retention rarely results in permanent retention after a varying period of catheter relief normal micturition begins again it is unlikely however that the bladder will be emptying completely and at shortening intervals further attacks occur until finally permanent retention becomes established.

Hæmaturia is not a prominent symptom sometimes however it is profuse causing clot retention when it does occur the prostate is usually large soft and congested. Intermission in the severity of the symptoms is a characteristic feature temporary exacerbations due to congestion of the gland being precipitated by indiscretions in diet—such as increased alcohol—constipation catching cold sudden changes in temperature etc.

The prostatic patient is always better in warm weather. Sexual irritation and increased desire may be troublesome and have led to tragic and distressing sequelæ in the police courts. In unrelieved cases symptoms of back pressure on the kidneys (*i.e.* chronic uræmia) occur sooner or later these consist of general malaise with loss of weight associated with thirst headache dryness of skin and the mucous membranes of the mouth and pharynx thus the tongue is dry and furred there may be difficulty in swallowing solid food and morning nausea is a common feature. The temperature is subnormal and the blood pressure often is raised. The backache is referred to the renal angle generally it is bilateral but may be entirely unilateral often it is worse during efforts to pass water.

When infection is superadded the urine becomes purulent and less in quantity and the patient develops a swinging temperature with sweating and more rapid loss of weight. The blood pressure falls and suppression of urine may supervene. The prostatic bladder is very prone to infection this may appear insidiously and spontaneously or may begin acutely *e.g.* following the passage of a catheter. Infection following catheterization is specially liable to occur when the bladder is chronically distended it occurs in spite of the most scrupulous asepsis and the infecting organism is invariably a *B. coli*—an auto infection for which the operator is liable to be blamed. Once the infection is established it is practically impossible to cure until the patient has been put in a position to empty his bladder again by prostatectomy.

### EXAMINATION OF THE PATIENT

This will follow careful investigation of the patient's history and symptoms he should be lying on his back on a couch or in bed attention is directed

first to the bladder, a distended bladder may be obvious to the eye and is readily palpable as a rounded elastic swelling extending upward from the pubes towards the umbilicus. If the bladder is not palpable it may be possible to determine its upper limit by percussion. If prior to this the patient has passed all the urine he can, some idea may be gained as to the presence and amount of residual urine.

Next, the loins are examined, and any enlargement or tenderness of either kidney noted. A rectal examination should now be made—best done in the knee elbow position—the size, consistency and mobility of the prostate are ascertained. The enlargement generally is uniform, is confined to the prostate, which presents a smooth convex rectal surface, is well defined and of homogeneous elastic consistency. The mobility of the gland can be estimated best by bimanual rectal and abdominal palpation.

It is a much discussed point whether a catheter should be passed to determine the amount of residual urine. If the bladder is distended and the patient free from pain, a catheter should not be passed at this first examination; should he be suffering from acute retention, however, temporary relief must be given with a catheter, but it is wiser at this juncture not to empty the bladder. The amount of residual urine is an important guide to the surgeon in advising for or against operation, and the responsibility of passing a catheter should be left to him. If it is obvious that there is a considerable amount of residual urine he will refrain, but if a catheter is deemed necessary it must be passed with the most scrupulous care and asepsis. Its unskilled use may cause hæmorrhage, false passages or sepsis, which may have most serious consequences. Before withdrawing the catheter, the bladder should be washed with an antiseptic solution (e.g. oxycyanide of mercury 1/8,000) and the patient subsequently given a urinary antiseptic by mouth for some days. If practicable, the urinary antiseptic should be taken also for a day or two before the catheter is passed.

Cystoscopic examination is desirable in all cases before operation, in straightforward cases this can be carried out as a preliminary at the time of operation; thus an unsuspected stone or diverticulum may be revealed. In certain cases cystoscopy is essential to establish diagnosis, for example, a patient presenting prostatic symptoms in whom no enlargement of the prostate is found on rectal examination, in such a case cystoscopy may confirm the diagnosis, or may reveal an unsuspected early tabes. Similarly all cases of hæmorrhage associated with enlarged prostate should be subjected to cystoscopy, lest an early carcinoma of bladder, or indeed of the kidney, be missed.

With an enlarged prostate the cystoscope will show a trabeculated bladder in which the hypertrophied muscle bundles are evident, and the interureteric bar will stand out as a solid ridge, which may be prolonged beyond the ureteric orifices. This prominent interureteric bar is especially evident in middle lobe obstruction, the trigonal muscle, arising at the ureteric orifices, is derived from the longitudinal muscle layer of the ureters, and below converges at the internal meatus where it becomes continuous with that of the urethra; its contraction tends to pull open the internal meatus. The regular outline of the internal meatus will be altered by the intravesical projection, and V-shaped gaps are seen between the different lobes. With the projecting prostate and raising of the internal meatus the prostatic margin is seen to lie much nearer the ureteric orifices than obtains normally (Marion's sign, 1921) with further projection, especially of the middle lobe, the trigone and ureteric orifices may be overshadowed completely.

X-ray examination should be carried out in all cases with prostatic

symptoms. Unsuspected calculi are sometimes revealed either in the urinary tract, or in the prostate itself. Intravenous urograms give valuable information about renal function, the presence of urinary tract dilatation or a vesical diverticulum, and a film of the bladder exposed immediately after passing water gives useful evidence concerning residual urine in the bladder. The cystoscope will show, not infrequently a stone in the bladder which gave no shadow with the X rays. Examination of the urine and investigation of the renal function are essential, for the latter the reader is referred to Chapter III. In the early stages the urine will be normal, later there is polyuria, the urine is of low specific gravity, pale in colour and deficient in solids and pigments, there may be a trace of albumen and, rarely casts. With the onset of infection it becomes cloudy and purulent.

### COMPLICATIONS

**Retention of urine.**—This may be acute or chronic. Anything which produces congestion of an enlarged prostate such as exposure to wet and cold, extra alcohol, constipation, etc., may be sufficient to precipitate an attack of acute retention. The patient is in pain, and distressed by frequent spasmodic contractions of the bladder in its effort to expel urine. The distended bladder may be felt above the pubes extending upwards towards the umbilicus. The retention may last from hours to days, before the urine begins to flow naturally again. Recurrence is inevitable sooner or later, and eventually attacks succeed one another with increasing frequency and severity, until a complete permanent retention results. Chronic retention, on the other hand, is a slowly developing painless distension of the bladder, eventually resulting in overflow and passive incontinence, the latter most marked at night. The patient suffers from frequency of micturition, but generally is unaware of his distended bladder, if this condition is allowed to persist he begins to suffer from thirst, headache, nausea, etc. (*vide* Uræmia).

**Infection and sepsis.**—Infection frequently follows catheterization, the infecting organism being the *B. coli*, and as it occurs in spite of the most scrupulous asepsis it is suggested that the catheter is only the exciting cause and that the infection is an auto infection rather than a catheter-borne one. A few hours after catheterization the patient has a rigor and the temperature rises, at the same time he begins to suffer from frequency of micturition and dysuria and is generally seedy, and the urine becomes cloudy and purulent. He may also experience a renal ache, unilateral or bilateral, and one or both kidneys may be tender. In severe cases the tongue becomes dry, the patient suffers from thirst, nausea, anorexia and hiccough and loses weight. He is constipated, drowsy and restless, the blood pressure falls, the urine becomes scanty and complete anuria may result. With stagnating residual urine, however, infection occurs without any instrumentation, its onset being more insidious and often passing unnoticed.

**Calculi.**—With infection, and when the urine becomes alkaline, phosphatic stones may be formed in the bladder. Lying in the post prostatic pouch and covered by residual urine, they may give rise to no symptoms. In addition to these stones which are secondary to infection, primary calculi composed of calcium oxalate or uric acid occur, with uninfected urine, in about 1 per cent of all cases of enlarged prostate.

**Epididymitis.**—This is a frequent concomitant of all urinary infections but seems especially liable to follow prolonged catheterization. When this is likely

to be necessary it is a wise procedure to tie the vasa deferentia first. Epididymitis used to be a common sequel to prostatectomy occurring in the second or third week in about 30 per cent of cases until ligation of the vasa deferentia became a routine. Infection of the vesiculæ seminales is common its importance lies in the fact that it may be a cause of persisting sepsis after prostatectomy. In all such cases the secretion from these glands should be collected by rectal massage and microscoped.

**Hæmaturia**—Hæmaturia often follows the use of a catheter. Spontaneous bleeding is less common it may consist merely of a drop of blood at the beginning or end of micturition or may be a sudden profuse bleeding into



FIG 239

Cystogram showing single diverticulum of bladder with an enlarged prostate

the bladder causing clot retention. The type of prostate in which this occurs is the large soft vascular benign one. It is rarely met with in carcinoma of the prostate.

**Diverticula**—Diverticula are common with enlarged prostate. They may be single or multiple and quite small or as large as or even larger than the bladder itself. The orifice by which a diverticulum opens into the bladder is usually small and is recognized with the cystoscope as a small round rather rigid opening in the bladder wall. They are most frequently situated at the back of the bladder or low down at one or other side. They may contain calculi and neoplasms may originate within them. With collapse of the bladder wall after cystostomy the opening of the diverticulum may become occluded and septic matter become bottled up within it. This may lead to serious trouble such as perforation or later as it prevents complete emptying of the bladder, may be a fertile source of continuous sepsis. Cystoscopy is advisable

in all cases of prostatic enlargement it is by this means that the presence of a diverticulum is discovered. A subsequent cystogram may help to define its size and position (Figs 239 and 240).

**Renal failure**—Both acute and chronic forms of renal failure occur. An example of the former is the suppression of urine resulting from the sudden emptying of a chronically distended bladder. Chronic renal failure is the result of continued and unrelieved back pressure on the kidneys. It is characterized by polyuria and subnormal temperature. The patient is sallow in appearance and loses weight; the tongue is dry and he suffers from thirst, anorexia, nausea, constipation, headache and backache (*vide* *Uræmia*).



FIG. 240

Cystogram showing multiple diverticula of bladder

**Secondary malignancy**—Twenty per cent. of all unoperated benign enlargements of the prostate eventually develop secondary malignant change. This is recognized by the appearance of a hard nodule or nodules in the substance of the gland, or commonly by infiltration and fixation at its lower end or one or other lateral margin. This risk of subsequent malignancy is a factor to be borne in mind in considering the pros and cons of operation.

#### COURSE AND PROGNOSIS

Enlargement of the prostate is a serious disease on account of the back pressure it produces and the ultimate sepsis. It is a progressive disease though progress may be slow or fast and unless relieved ends fatally from one of these causes. The size of the prostate is little criterion of the amount of obstruction it is producing. The patient either passes through a stage of frequency of

micturition and bladder irritation to one of increasing obstruction and retention, or undergoes with little or no local symptoms, a slow, chronic retention resulting in overflow incontinence. Meanwhile there is developing a back-pressure nephritis, and with the advent of infection, ascending pyelonephritis. The wise patient will not await the onset of retention before seeking medical advice and although at the stage which he seeks guidance operation may not be necessary it may be expedient. The patient tends to take a short view, whereas the surgeon must take a long one. In other words, he must balance the immediate risk of operation while the prospect is good against the ultimate risk when it may be bad. So long as the residual urine is under 4 oz. and the prostate is not interfering seriously with his activities and his sleep, it is safe to temporize. When the residuum is greater than this, operation generally is advisable, the only ultimate alternative is a catheter life, which few patients survive more than two to two and a half years. Each case must be judged on its own merits after due consideration of the general condition of the patient, his prospect of life, his cardiovascular system and the functional value of his kidneys. Infection of the urine is not a bar to operation provided the renal functional tests are satisfactory, in fact, a patient with a urine already infected has acquired some immunity and tends to run a more benign post operative course than one with an uninfected urine.

### DIAGNOSIS

Frequency of micturition, most marked at night, and of the prostatic type, commencing after the age of 50, and with a clear urine, almost certainly is due to an enlarged prostate. The diagnosis will be confirmed by rectal and cystoscopic examinations. Careful investigation of the history and examination of the patient will avoid fundamental errors in diagnosis, such as mistaking the digestive disturbances of renal failure for gastritis or carcinoma of the stomach and its polyuria, for diabetes insipidus. Both are mistakes which would have been avoided had the abdomen been examined and the distended bladder recognized. Diagnosis of benign enlargement of the prostate must be made from other causes of urinary obstruction and from other causes of prostatic enlargement.

1 Other causes of urinary obstruction. (a) Stricture of the urethra (b) Diseases of the nervous system (c) "Bladder-neck obstruction" (d) Vesical growths

2 Other causes of enlargement of the prostate. (a) Prostatitis and prostatic abscess (b) Carcinoma of the prostate (c) Prostatic calculus (d) Tuberculous disease of the prostate

1 Other causes of urinary obstruction—(a) STRICTURE—If, on attempting to pass a catheter, obstruction is found anterior to the prostatic urethra, urethroscopic examination is indicated, it may be impossible otherwise to distinguish between an organic obstruction and obstruction caused by spasm of the compressor urethrae. A stricture generally manifests itself before the patient reaches the prostatic age, and the early history is one of increasing difficulty rather than frequency of micturition, moreover, the urine is already cloudy from infection, or at least contains urethral or prostatic threads. Unless there is coexisting prostatic hypertrophy the prostate will be found, on rectal examination, not to be enlarged.

(b) DISEASES OF THE NERVOUS SYSTEM—Diseases of the spinal cord may disturb bladder function, thus frequency of micturition is a common early symptom of disseminated sclerosis, but the disease most commonly causing

obstruction is tabes. No examination of the urinary tract is complete until the reflexes have been examined with well established tabes the absent knee jerks Argyll Robertson pupils and ataxia render the diagnosis easy. Difficulty in micturition is an early symptom of tabes however and may occur before these characteristic features appear. Frequency of micturition is absent until infection occurs but nocturnal incontinence is fairly common. Diagnosis can be established generally by cystoscopy which shows a fine atrophic type of trabeculation characteristic of spinal disease. In tabes there is early loss of sexual power whereas with enlarged prostate it is retained or even increased. Thomson Walker (1916) described a condition of Primary Atony of the Bladder without obstruction or signs of nervous disease. These cases present a long history of increasing difficulty beginning in the second or third decade and progressing to complete retention. The same atrophic trabeculation is present as in tabes. In this condition in which the bladder musculature is at fault the lack of bladder tone will be noticed when a catheter is passed the urine drops from the end of the catheter and the bladder lacks any power of propulsion.

(c) **BLADDER NECK OBSTRUCTION.**—This condition appears under various names—prostatism, sans prostate and atrophy of the prostate in the French literature while it is described by American writers as median bar obstruction. The bladder neck becomes infiltrated with fibrous tissue probably dating from previous prostatitis and so fails to open hence Legueus (1912) term *Dysectasia*. There is a long history of difficulty and frequency beginning before the age of 40 but no prostatic enlargement. The cystoscope which may be gripped at the bladder neck as by a stricture shows a back pressure bladder similar to that found with enlarged prostate but there is no intravesical prostatic projection. The characteristic condition seen is a thickening of the posterior lip of the internal meatus which forms a transverse bar at the junction of bladder and posterior urethra and when viewed with the endoscope it is seen that the meatus fails to open and contract normally as the water is turned on and off. Young (1926) lays stress on the fact that with a cystoscope in the bladder a finger in the rectum can detect thickening and induration in the median portion of the prostate and the beak of the cystoscope which normally may be felt through the trigone may not be palpable.

(d) **VEGETAL GROWTHS.**—A papilloma growing near the internal meatus may cause difficulty in micturition as it is carried downwards in the urinary stream but hematuria will be the outstanding feature and small pieces of the growth are broken off and may be recognized in the urine. A carcinoma low down in the bladder wall may infiltrate the prostate but the increase in size will be limited to one side of the gland and its upper and outer margins will have lost their definition. Cystoscopy will elucidate the diagnosis.

2 **Other causes of prostatic enlargement.**—(a) **PROSTATITIS.**—In chronic prostatitis the prostate is irregular tender firm and little if at all enlarged. If it is at all enlarged it is boggy rather than uniformly elastic like an adenomatous prostate moreover it nearly always is associated with vesiculitis so that these structures are palpably enlarged and thickened. There is no intravesical projection of the prostate the urine is purulent or contains urethral or prostatic filaments and the secretion expressed by rectal massage contains pus cells and cellular debris from the prostate. Occasionally an acute primary prostatitis is met with which may be confused with enlarged prostate. It begins suddenly with frequency dysuria and increasing difficulty progressing rapidly to retention of urine. The prostate is uniformly enlarged tense and tender and the temperature is raised. The urine may be perfectly clear



After a few days a soft spot appears in one or other lobe indicating abscess formation. This type of prostatitis is due to a staphylococcus aureus and may be associated with a boil or some other skin lesion.

(b) CARCINOMA OF PROSTATE—The age incidence is much the same as that of benign enlargement though not infrequently carcinoma is met with at a slightly earlier age *e.g.* the early fifties. The early history is one of increasing difficulty in micturition rather than frequency. Pain which is absent in simple enlargement may be a feature of carcinoma especially sciatic pain. Rectal examination will reveal an irregular prostate with characteristic hardness and fixation. Possibly induration may be felt extending to one or both vesicles and laterally the normal prostatic outline may be ill defined or lost. Sarcoma of the prostate is a rare disease and practically unknown at the prostatic age. It either forms a large soft swelling which does not involve the whole gland or is mainly perivesical or retrovesical.

(c) PROSTATIC CALCULI—A single stone in the prostate or prostatic urethra is more likely to be mistaken for carcinoma than benign enlargement. An X ray film will settle the doubt (Fig 278). When the stones are multiple it may be possible to feel crepitus on rectal examination as they grate against one another. A stone in the prostatic urethra can be felt on passage of a metal instrument. The urine nearly always is cloudy and infected and sometimes a little blood appears at the beginning or end of micturition.

(d) TUBERCULOUS DISEASE OF THE PROSTATE—This is a disease of an earlier decade and if met with at a prostatic age it will be accompanied by other evidence of tuberculosis in the genital or urinary tracts which will render diagnosis obvious.

S G MACDONALD

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## CHAPTER XXXVIII

### TREATMENT OF COMPLICATIONS OF SIMPLE ENLARGEMENT OF THE PROSTATE AND NON-OPERATIVE TREATMENT OF SIMPLE ENLARGEMENT

**A**CUTE RETENTION should be relieved as soon as possible. The patient is given a  $\frac{1}{2}$ -gr morphia suppository or a  $\frac{1}{2}$  gr of morphia hypodermically, and placed in a hot bath. Should he fail to pass water in the bath he must be relieved forthwith by catheter. The strictest aseptic precautions must be adopted, the hands of the surgeon being washed, the penis swabbed and, when possible, the urethra irrigated with some antiseptic solution. Next, with a syringe or ordinary pen-filling pipette 1 or 2 drams of a 4 per cent solution of novocaine are instilled into the urethra. This not only helps the patient by relieving pain, it helps the surgeon also by abolishing spasm and resistance of the compressor urethrae muscle. The best type of catheter to use is the "Marshall" (made originally by Bell & Croydon), this is made both in rubber (known as Tiemann's catheter) and 'gum elastic' and can be boiled, it has a curved olive-tipped end and the rubber "Marshall" being firmer than the ordinary rubber catheter, and the gum-elastic one softer and more flexible than the ordinary gum elastic (Figs 241 and 242). With its curved end and its flexibility this catheter rarely fails to find its way through the angulated prostatic urethra, it should be passed with the greatest gentleness, no force is permissible. A hard, straight or rigid instrument should not be used, it results in hemorrhage and false passages, and fails to relieve the retention. The best sizes to use are 8, 9 or 10 (English scale). Should the "Marshall" fail, a coude or bicoude, size 18 or 20 (French scale), can be tried—a larger size often passing more easily than a smaller one. As a final resort the long-curved silver prostatic catheter may have to be used. The patient should be kept in bed until natural micturition is re-established, meanwhile he should drink copiously (4 to 5 pints daily) and take some urinary antiseptic such as sulphonamide. It is wise to wash the bladder with a mild antiseptic solution after each catheterization. If relief cannot be afforded by catheter, the bladder must be opened and drained suprapubically. If the catheter passes into the bladder but no urine flows, the eye of the catheter probably has become blocked by a blood clot, which can be displaced by syringing a small quantity of saline solution through the catheter. "Clot retention" means that the bladder is full of blood clot which cannot be emptied by catheter.

**Chronic retention**—The slow, chronic, painless retention is a much more serious condition, as the kidneys have been subjected to increasing back pressure for a considerable time, and their function generally is impaired. Two dangers must be guarded against—firstly, the sudden emptying of the bladder and secondly, infection. The sudden emptying of the bladder and consequently sudden relief of back pressure on the kidneys may result in suppression of urine, it is more likely to occur when the blood pressure is high or the specific gravity of the urine low. In the same way the sudden relief of tension, and consequent congestion of the whole urinary tract, may

result in hæmorrhage from bladder, ureters and kidneys. The back-pressure bladder is more prone to infection, and once infected more difficult to cure. It should be an axiom that when the arteries are poor, the blood-pressure high, or the specific gravity of the urine low, the bladder should be emptied slowly. The patient should be put to bed for a day or two before any instrumentation is attempted. He should be given large quantities of fluids and a urinary antiseptic. The object in mind is to empty the bladder just a little faster than the urine is being secreted, over a period of forty eight hours, so that the kidneys may accommodate themselves to the gradually decreasing tension.

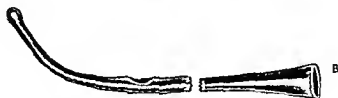


FIG 241

A Vulcanite tap which fits tightly into the funnel end of catheter B Marshall catheter

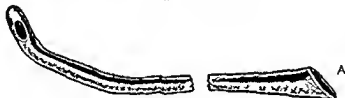


FIG 242

A Bicoode catheter B Coude catheter

This is best done through a watertight suprapubic stab puncture made after exposing the bladder, otherwise a catheter is tied in to the bladder, either a tap is attached to the end of the catheter (Fig 241, A) and adjusted so that the urine comes out in a steady drip, or the catheter may be controlled by a spigot and 10 oz withdrawn every two hours until the bladder is empty. Should this not relieve the tension fast enough, the amount may be increased to 12 or 15 oz. Another method is to plug the catheter with a spigot, then to thrust a hypodermic needle into the catheter behind the spigot and allow the urine to drip from the end of the needle. There may be a little bleeding when the bladder is emptied but this is controlled by lavage with 1 in 10 000 silver nitrate solution. Once the bladder has been emptied safely, and until the next step is decided, either the catheter should be retained or the bladder emptied by passing a catheter at regular intervals.

**Infection and sepsis**—If we take as a type infection following catheterization the patient should be confined to bed and placed on a light or medium diet—eliminating alcohol meat and meat extracts condiments and spices—he should drink copiously and be given a urinary antiseptic by mouth. In most of these cases and where the residual urine is small in amount or non-existent the temperature returns to normal in two to three days though pyuria remains. Fluids should consist of plain water barley water or one of the minerals such as *Contrexville* *Lian* or *Vichy* and weak China tea. Barley water should be an infusion of natural barley i.e. barley with the husk on (not pearl barley) and is made as follows: two ounces of natural barley three lumps of sugar and the rind of one lemon are placed in a large jug or basin and 1 gallon of boiling water poured on to them. This is poured off when cold and makes a clear palatable drink.

With regard to urinary antiseptics sulphathiazole (M & B 760) is the most generally effective of the sulphonamides and is effective in lower concentration than sulphapyridine (M & B 613). Apart from its value in *B. coli* infections sulphathiazole is now the antiseptic of choice in staphylococcal and proteus infections. It may be effective also in infections caused by the streptococcus faecalis though with the latter organism mandelic acid is more efficient as this must be in concentrated solution in the urine and necessitates a reduction of fluid intake to 2 pints a day. It is best withheld until the temperature has returned to normal. In more severe infections and in cases where the residual is large it is of the utmost importance to secure free bladder drainage either by a retained catheter or by suprapubic cystostomy. Should nausea or sickness prevent sufficient intake of fluids by mouth and in any case when the renal secretion is low a continuous intravenous drip of normal saline and 5 per cent glucose (isotonic) should be initiated. This is the simplest and most certain method of re-establishing the renal secretion. Except in an emergency the patient is better without diuretics which only deplete the tissues of fluid.

**Calculus**—Vesical calculus occurring with an enlarged prostate are merely an incident in the course of the prostatic enlargement and should be treated as such. They should be removed by suprapubic operation either at the time of the prostatectomy or at the first stage when a two stage operation is performed. Crushing a stone in these circumstances may be a hazardous procedure and often is followed by retention. Moreover recurrence of stone is certain as the original factors causing the stone (residual urine and infection) remain.

**Epididymitis**—This should be treated by elevation and heat the scrotum being raised on a small cushion or pad and heat applied either by hot fomentation or by antiphlogistine. Catheterization should be avoided as far as possible as long as the inflammation persists. Generally the swelling begins to subside after seven to ten days rarely however it progresses to abscess formation the skin grows dusky and adherent at one point which subsequently becomes shiny soft and fluctuant and unless incised breaks down and discharges pus.

**Hæmaturia**—When slight such as a drop of blood at the beginning or end of micturition no special treatment is necessary should it be persistent or sufficient to colour the urine. Irrigation with 1 in 10 000 silver nitrate solution will probably stop it. For recurring hæmorrhage X-ray treatment may be advised with a fair prospect of success if it recurs sufficiently often or with sufficient severity to produce anemia a two stage operation is indicated. With suprapubic cystostomy the bleeding will cease after this the anemia can be treated with iron or liver extract or even by a blood transfusion the drainage being maintained until the blood picture warrants prostatectomy. A severe hæmorrhage resulting in clot retention will necessitate a suprapubic cysto-

stomy old clots may be evacuated by a Bigelow's evacuator but when active prostatic bleeding is going on operation is a wiser procedure

**Diverticula**—As a general rule diverticula should be excised either at a preliminary operation or at the time of the prostatectomy according to the condition of the patient. Exception may be made however in the case of a small one in which the opening is not too small and is situated well above the base of the bladder. The ureteric orifice must be defined before operation as in a small number of cases it lies inside the diverticulum.

**Renal failure**—*Chronic* renal failure is due to the gradual destruction of renal tissue such as occurs in unrelieved prostatic obstruction. The indications are to relieve the obstruction by a suprapubic stab puncture after exposing the bladder for preference or by a tied-in catheter and to stimulate the renal secretion by increasing the fluid intake. If and when the kidneys respond sufficiently suprapubic drainage is substituted for the catheter the suprapubic tube being retained permanently or until the patient is deemed fit enough to undergo prostatectomy. In *acute* renal failure such as may follow the sudden emptying of a distended bladder the anuria is due to renal congestion from the sudden relief of tension. Here again drainage must be maintained while every effort is made toward the re-establishment of the renal secretion. Hot fomentations are applied to the loins free action of the skin stimulated by radiant heat and fluid—normal saline 5 per cent glucose (isotonic) or 4.3 per cent sodium sulphate—given by continuous intravenous drip. A diuretic such as theocin sodium sulphate (gr v) may be given and the bowel action should be encouraged by a saline aperient. If the blood pressure has fallen materially an injection of pituitrin may be valuable.

### NON OPERATIVE TREATMENT OF SIMPLE ENLARGEMENT OF THE PROSTATE

This is applicable only to early cases and cases in which there exists some serious contraindication to operation.

**Early cases**—General treatment will be directed towards securing a well ordered life preferably in a warm climate. The patient must guard against cold chills and over exertion all conditions liable to produce some congestion and increased difficulty in micturition. Difficulty is increased by holding the urine after the call to micturition comes and must be guarded against by avoiding occasions when this might arise such as long journeys by train car or air. Constipation also should be eliminated a well ordered diet and mild exercise such as walking or golf should ensure a daily evacuation. Alcohol taken in moderation need not be forbidden it rarely causes trouble so long as the patient does not exceed his accustomed ration but he must avoid the extra glass. A city dinner is a most fertile source of retention in prostatic patients. The most suitable form of alcohol is whisky or a light wine. Nocturnal frequency may be relieved to a certain extent by mild sedatives such as bromide and luminal and urinary antiseptics are indicated when the urine becomes infected apart from this drugs offer little help except in relieving concomitant symptoms. Prostatic massage so necessary in the treatment of chronic prostatitis is undesirable in the case of an enlarged prostate and may prove harmful. Early cases should be re-examined from time to time and both the residual urine and renal function watched carefully. Organotherapy based on the fact that with an enlarged prostate there is a diminution of androgen in the urine cannot be considered a substitute for operation when much obstruction exists. It may be tried in early cases but up to date the results have been disappointing. Though the male hormones tone up the bladder musculature improve the

general health and give rise to a sense of well being there is no evidence that they produce any diminution in the size of the prostate Draper (1940) in a series of cases found no improvement following injections of testosterone but much more work remains to be done on this subject before any conclusion can be drawn Deep X ray therapy probably relieves local congestion and may cause some improvement in the troublesome frequency of micturition but it produces no diminution in the size of the gland and at best any benefit derived from it is purely temporary It is not devoid of risk it is difficult to gauge the optimum dose for each individual and an X ray burn may prove more troublesome than the prostate X rays should not be applied when the urine is infected it will produce increased difficulty in micturition and may precipitate retention

Cases in which operation is contraindicated—Many of these will be cases with high residual and poor renal function and bad cases of infection a large number of them can be improved sufficiently for operation to be a justifiable risk The important points in treatment are to secure a large diuresis by intake of sufficient fluid to produce a minimum of 80 to 100 oz of urine in twenty four hours and to empty the bladder at regular intervals by catheter or to keep it empty by means of a tied in catheter The bladder meantime should be washed morning and evening with a mild antiseptic (such as oxycyanide of mercury 1 in 5000) and a urinary antiseptic taken by mouth These two factors in preliminary treatment (viz securing a large diuresis and bladder drainage) have been responsible chiefly for the large decrease in operative mortality Patients presenting cardiovascular difficulties or diabetes should be handed over to the physicians for pre operative treatment When operation is vetoed finally the patient will have to embark on a catheter life

S G MACDONALD

## CHAPTER XXXIX

### SUPRAPUBIC PROSTATECTOMY

THE operation of prostatectomy means removal of the prostate gland, but in the case of simple enlargement or adenomatous disease a mass of pathological tissue is enucleated with the finger from within a capsule of fibrous tissue enclosing gland substance. The larger the tumour or tumours, the smaller and more atrophic (owing to pressure) is the amount of prostate gland to be found in this fibrous sheath.

The modern operation of suprapubic prostatectomy has developed in successive stages from a partial to a total removal of multiple prostatic adenomata. At the same time the technique has changed from an excision of the intravesical portion then a removal of the whole mass by blind operation, to complete enucleation followed by reconstruction of the anatomy of the bladder base, internal meatus and torn ends of the urethra.

The introduction of floodlighting into a body cavity and the invention of instruments designed to overcome the operator's difficulties have placed the technique of this operation on an equality with that of the surgery of any other organ.

#### THE HISTORY OF SUPRAPUBIC PROSTATECTOMY

Attempts to remove the enlarged prostate by the suprapubic route date back to 1836, when the French surgeon Amussat excised the middle lobe with scissors, but it was not until 1887 that McGill of Leeds urged surgeons to perform this operation as an efficient substitute for catheter life. Belfield of Chicago in the same year reported that he had excised the middle lobe, but he did not share McGill's enthusiasm for it. In a subsequent paper published in 1890 he reviewed the cases of suprapubic prostatectomy which had been performed over eighty times and found that "in nearly one third of cases on record the radical operation failed to restore voluntary urination," due, so he thought, to bladder atony. Another cause was detected by him, namely, that the operation failed to remove the prostatic obstruction and that the intravesical projection constituted but a part of it.

McGill held the view that "retention was caused by valve-like action of the intravesical prostate, the urethral orifice being closed more or less completely by the contraction of the bladder on its contents."

After the death of McGill in 1890 no surgeon continued this line of clinical research and prostatectomy fell into disfavour.

William White of Philadelphia in 1893 still further discouraged any operation on the gland itself, by suggesting that castration alone might cause shrinkage of the prostatic overgrowth. This suggestion was readily taken up, and many elderly men had to submit to removal of both testicles with unfortunate results. Mental disturbances were the rule, rather than the exception. William White had made this proposal after studying John Hunter's experiments on animals but he failed to realize that, whereas Hunter had experi-

mented upon the normal prostate he was advocating a similar experiment on man which was to cause atrophy of tumour tissue. If the enlargement of the gland were due to hypertrophy the surgeons who put into practice William White's suggestion would have obtained satisfactory results. Vasectomy as a less severe and mutilating operation was given a trial with results equally unfortunate.

In more recent times division of the vas deferens has been reintroduced into Europe, the technique varying between vasectomy and ligation of the ducts of the epididymis. Such operations are advocated without any regard for the pathology of the disease and are the outcome of the elderly man's well understood fear of the effect of a major operation.

In order to ensure that the claims made for it were based on reliable evidence a trial was given in the technique at a Municipal Hospital in the London area. There was no selection of cases apart from the necessity for an accurate diagnosis. Retention of urine and difficulty of micturition due to prostatitis were excluded and only those patients were operated on who were suffering from adenomatous enlargement. Under gas oxygen anaesthesia the ducts of the epididymis were ligated in twelve cases with residual urine varying from 4 to 10 oz. Post operative catheterization was avoided. At the end of ten days with the wound in the scrotum healed the residual urine was tested. In all cases no change had occurred and in some the effects of back pressure were more marked.

The final results were that most of the patients had to submit to prostatectomy in two stages instead of one.

In 1897 Fuller of New York wrote an important article in the *Journal of Cutaneous and Genito Urinary Diseases*. He argued that the results of prostatectomy were unsatisfactory because the removal of the hypertrophy was incomplete and that no attempt had been made to remove the hypertrophies surrounding the prostatic urethra. 'If all the hypertrophies median, lateral and round about the prostatic urethra are removed the results so far as the bladder is concerned are barring mortality satisfactory.'

Fuller enucleated by the suprapubic route the prostatic obstructions *en masse* and did not desist until all the lateral and median hypertrophies as well as all the hypertrophies along the line of the prostatic urethra have been removed.

Thomson Walker in his review of the history of prostatectomy (1930) points out that Fuller's article was the first to stress that the routine operation of suprapubic prostatectomy must include the hypertrophies along the prostatic urethra—in other words the rectal enlargement as well as the intra-vesical projection.

It is strange that so little attention was paid to the work of the American surgeon. His contemporaries still toyed with William White's idea of castration.

The renaissance of prostatic surgery occurred in 1901 when Freyer published four cases of what he described as a new and at first sight formidable operation for radical cure of the enlarged prostate. Freyer was a forceful advocate and an attractive showman. He was confident that the results of the treatment of simple enlargement of the prostate would be revolutionized by his operation. Time has shown that he was right but his claim to have introduced complete prostatectomy cannot be substantiated. By his writings Freyer proceeded to popularize his technique and to show that normal micturition could be restored even after so 'formidable' an operation. His mortality rate was lower than anyone had conceived possible during the next twenty



bladder neck proved correct. Nevertheless Thomson Walker's operation put an end to the criticism that prostatectomy was a crude affair.

The next step was to ensure that there should be complete control of reactionary hemorrhage and reconstruction of tissues damaged by the removal of the prostatic adenomata and urethra. The first surgeon to accomplish this was Harry Harris of Australia, his original paper appearing in 1927. The details of his operation and the modifications introduced by the author will be described later.

Throughout the period under review, namely from 1836 until the present time (1942) numerous attempts were made to remove the prostate by the perineal route. In recent years Young of America and Wildboltz of Switzerland have been successful in developing a technique for which excellent results have been claimed. In this chapter we are concerned only with the suprapubic operation.

### SELECTION OF CASES FOR PROSTATECTOMY

In all cases of prostatic obstruction it is essential to determine its cause before the nature of the treatment is decided. The importance of accurate diagnosis cannot be overestimated. To the most experienced this may prove a considerable difficulty. This arises from the fact that chronic inflammation of the gland is superimposed on adenomatous disease. Likewise nodules of fibro adenomatous tissue may be mistaken for carcinoma and the latter for calculi. If rectal palpation fails to give a clear cut picture of the pathological condition of the prostate cystoscopy is indicated. The gland must also be X-rayed to exclude the presence of calculi. The surgeon must satisfy himself that the condition is a suitable one for the technique of enucleation. Although adenomata may be present the bulk of the enlargement may be made up of chronic inflammatory tissue. In this case the prostate does not give the sensation of elasticity to the palpating finger per rectum nor has it the free mobility typical of uncomplicated adenomatous disease. Fanculation is not the correct treatment for this type of prostatic obstruction. The next step is to consider the state of the urinary organs, namely the changes which have taken place in the kidneys, ureters and bladder. Finally the general condition of the patient must be studied. Successful prostatectomy by enucleation is dependent on (1) a correct diagnosis of the cause of the prostatic obstruction, (2) the changes in the urinary organs, (3) the general condition of the patient.

**Methods of investigation.**—The type of enlarged prostate which is suitable for removal by enucleation is determined by (a) rectal palpation, (b) cystoscopy, (c) amount of residual urine.

**RECTAL PALPATION.**—By this means the gland must give a sensation of elasticity to the palpating finger. The outer margin of the organ must feel quite distinct from the surrounding tissues. If the glandular tissue is merged into that immediately beneath the mucous membrane of the rectum it is evidence of the presence of either periprostatitis or malignant disease. With the tip of the finger it should be possible to feel the upper limit of the prostate which in adenomatous disease is distinct from the tissues of the base of the bladder. Impaired mobility of the organ is an indication that the case is unsuitable for suprapubic enucleation. In some patients owing to muscular rigidity it is not possible to carry out a satisfactory rectal examination. The surgeon must then insist on investigation under anaesthesia, either low spinal, intravenous or gas and oxygen, at the same time the patient can be cystoscoped.

bladder where the cardiac lesion is the most prominent sign of renal insufficiency and the urinary the least. In the late stages the patient has a sallow complexion, a tired appearance and an anxious expression.

A thoroughly trustworthy aid to the estimation of the risks of prostatectomy is intravenous pyelography. The X-ray pictures demonstrate two things: first, whether the kidneys are capable of excreting the pyelographic substances and in what amount; second, the anatomical changes in the pelvis and calyces. As regards the latter it has been demonstrated that even in an extreme degree of hydronephrosis involution will take place following the removal of the cause. Therefore uncomplicated bilateral hydronephrosis is not necessarily a contraindication to prostatectomy. On the other hand a failure of the kidneys to excrete the whole of the pyelographic substance shows that a major operation on the prostate will end fatally. If there is a limited amount passing through the urinary tract prostatectomy may be undertaken with good prospects of success provided the clinical findings are satisfactory and sepsis is mild.

**Laboratory tests.**—A large number of tests to measure renal function have been introduced during the last fifty years. The surgeon should select one or two of these and make himself fully acquainted with their technique and limitations; otherwise confusion results. Cuthbert Dukes (1939) points out that three general considerations must be kept in mind when renal function tests are employed: in the first place they only detect gross deviation from the normal; secondly they are easily influenced by extrarenal factors; finally, deductions from these tests only apply on the day on which the test is carried out and should be as near the proposed date of operation as possible. The two most reliable ones are the estimation of urea in the blood and its concentration in the urine. Maclean's test (see chapter on Renal Function Tests).

The level of the blood urea may be raised in so many diseased conditions that care must be taken when using this test of renal failure to exclude all possible causes outside the urinary tract which may influence the result. The normal urea content of the blood is from 20 to 40 mg. per 100 c.c. but in elderly men this may be raised to 50 per 100 c.c. without indication of renal damage. Provided the clinical findings are satisfactory a rise to 55 mg. per 100 c.c. will not contraindicate a major operation upon the prostate but anything above that figure must be deemed to be a sign of serious impairment of the kidney function.

Rare cases are met with when, after preliminary bladder drainage, the blood urea remains at a high level and yet the patient's general state of health is good. To condemn such a man to a permanent suprapubic apparatus is not good surgery. The urologist must have courage as well as sound judgment and if he considers the results of the laboratory tests do not conform to his opinion of the general condition of the patient, he must base his opinion on treatment by the clinical investigations only.

The urea concentration test (Maclean and de Wesselow) is reliable in cases of enlarged prostate provided that during the collection of specimens of urine the bladder is drained by catheter. (For details of test see chapter on Renal Function Tests.) The percentage of urea is estimated separately in the four samples of urine which are collected at intervals of one hour. The volume of the last three specimens must also be recorded. A concentration of urea of 2 per cent in any one specimen may be considered satisfactory but a lower percentage affords evidence of renal damage. Therefore when the readings are below 2 per cent prostatectomy is contraindicated without preliminary

bladder drainage The test must be repeated fourteen days later before deciding whether the major operation can be performed

More reliance can be placed on Maclean's test than on estimation of the blood urea, on account of the extrarenal influences upon it Should the blood urea be high, but the concentration of urea in the urine satisfactory, the former can be disregarded

**RENAL SEPSIS**—Infection superimposed on kidneys damaged by back pressure is a serious complication and cannot be combated to the same extent as when renal dilatation alone is present

Bladder drainage, except in the most extreme cases will suffice to overcome the dilatation of pelves and calyces, but it has little effect, *per se*, upon septic pyelonephritis There are no laboratory tests of the degree of kidney infection, and reliance must be placed entirely on clinical findings It cannot be emphasized too strongly that however satisfactory may be the tests of renal function the presence of severe sepsis in the upper urinary tract is of grave omen, the common organism is the *B coli* If an adenomatous prostate is complicated by chronic pyelonephritis its removal is always accompanied by a stormy convalescence The presence of pyelonephritis does not in itself contraindicate the operation, because often the risk to life of non-interference of the diseased gland is the greater

Apart from the results of bacteriological examination of the urine the indications of the presence of renal infection are a furred tongue and intermittent rises of temperature Tenderness of the kidneys on palpation of the loins is only detected when the infection is acute

If there is a history of one or more rigors the prognosis in relation to prostatectomy is bad On no account should this operation be performed when there is a rise of temperature It is a wise rule to allow a week to elapse with no fever before the prostatectomy There is no known drug which will cure chronic pyelonephritis of *B coli* origin There are cases on record in which the sulphonamides have appeared to sterilize the kidneys, but they are no more to be relied on than any of the well-advertised urinary antiseptics The only treatment which is of any avail is continuous bladder drainage combined with forced diuresis Attention to the bowels is also imperative Much patience is demanded, for this treatment may be needed for many weeks preliminary to prostatectomy When the infection is confined to the bladder it will clear up quickly as the result of drainage and constant irrigation

**THE GENERAL CONDITION OF THE PATIENT**—*The vascular system*—When the surgeon is in any doubt about the condition of the heart and blood vessels it is his paramount duty to seek the advice of a physician as well as an anaesthetist It has already been pointed out that many of the heart lesions associated with prostatic obstruction are directly attributable to urinary sepsis If some form of surgical intervention is imperative in the presence of a cardiac lesion it is wise to perform a cystostomy under local anaesthesia and carefully observe the effect on the heart of the continuous bladder drainage Should a steady improvement result it would be obvious that the urinary obstruction was the cause of the vascular lesion and after an interval of time the urologist can proceed with the prostatectomy

Changes in the blood vessels are common Arteriosclerosis is present in nearly every case but is no contraindication to a major operation

Blood pressure alterations from the normal play a very important part in their effect upon the post operative convalescence A low blood pressure causes more anxiety than a high one Thrombosis and pulmonary embolism are more likely to occur with the former, and reactionary hæmorrhage with the

latter. Bleeding at the time of operation can be controlled but it is not known how to prevent embolism. The occurrence of thrombosis seems inevitable in a proportion of those cases in which sepsis and a low blood pressure are combined. Immobilization in bed is also a contributory cause.

*Glycosuria*—The presence of sugar in the urine whether due to diabetes or senile glycosuria is a serious portent. Sepsis becomes established quite early and in spite of the control of sugar metabolism by insulin cannot be entirely eliminated. Operative interference frequently gives rise to an infection which fails to respond to any known remedies. Secondary hemorrhage and gangrene are common (see Chap. LXXXIII).

*Gastro intestinal lesions*—Besides the disease of the prostate in some cases there may be a second pathological lesion in the gastro intestinal tract. Ulcers of the stomach, duodenum and large bowel are occasionally complications which undiagnosed on account of the predominance of the urinary symptoms flare up during the post operative convalescence and in themselves will cause a fatal result. These ulcers have been known to give rise to severe hemorrhage or perforation within a few days of the prostatectomy. If ulcerative colitis is present death will ensue within the first ten days. It has been suggested that these ulcers of the large bowel are uræmic in origin but there is neither clinical nor pathological evidence to support this theory. If a voluntary evacuation of the bowels takes place within the first forty eight hours of operation ulcerative colitis must be suspected.

It is possible on occasions to diagnose these lesions of the gastro intestinal tract anyone of which will contraindicate a major operation upon the prostate when the patient first submits to examination. A history of attacks of diarrhoea and the passage of mucus must immediately put the surgeon on his guard but often the disease is so quiescent that the symptoms are negligible. It is still less easy to recognize the presence of an ulcer of the stomach or duodenum for flatulence and indigestion are concomitant signs of renal failure. Again if the signs and symptoms excite the slightest suspicion the patient must be submitted to a medical examination before embarking on the treatment of the genital lesion.

There are few cases of prostatic obstruction which are not constipated. In taking the medical history it is important to question the patient concerning the action of his bowels. The difficult and dangerous cases are those of concealed constipation. It is a fact that every patient with chronic distension of the bladder suffers from this condition. When under cross examination he will insist that he has a daily action of the bowels which is probably true but he never empties his colon the rectum alone being evacuated. Just as the bladder becomes atonic from the large quantity of residual urine so does the bowel from retained feces. This condition is such that if a prostatectomy is undertaken there is grave danger that the patient will die from intestinal toxæmia. In these cases bladder and bowel drainage must be simultaneously carried out the one to relieve the back pressure on the kidneys the other to cure the patient's sapræmia. Daily enemata are often needed for ten consecutive days before the whole of the colon can be emptied.

**Summary**—1 The urologist must satisfy himself that the prostatic obstruction is due to adenomatous disease.

2 In view of the age of the patient the possibility of a second pathological lesion must always be borne in mind.

3 Renal failure and renal sepsis contraindicate an immediate prostatectomy. Bladder drainage must be instituted until clinical findings indicate that these complications are under control.

## PRE-OPERATIVE PREPARATION

**Bladder drainage**—The bladder is drained by two methods (1) the indwelling catheter (2) suprapubic cystostomy

1 **THE INDWELLING CATHETER**—In those cases where there is moderate renal failure or sepsis is confined to the bladder (excluding that due to a large diverticulum) a catheter tied in the urethra and draining *continuously* for ten to fourteen days will be effective in ensuring that a one stage prostatectomy can be performed at the end of that time. A gum elastic catheter retains its position better than a rubber one but is not so comfortable for the patient. A size 20 Charriere is used and is fixed by tapes and strapping to the penis. By forced diuresis and bladder lavage three times daily with a weak antiseptic lotion the interior of the catheter can be kept free of phosphates and mucus. The greatest care must be taken that blocking does not occur. If the urine is very dirty it is dangerous to drain by catheter. Another contraindication to drainage by this method is the early onset of urethritis. If this is ignored periurethral abscesses may occur with subsequent formation of stricture.

2 **SUPRAPUBIC CYSTOSTOMY**—The indications for this method of drainage are severe renal failure, sepsis and intolerance of the urethra to a tied in catheter. Other indications are the presence of bladder calculi, large diverticula and hemorrhage from the prostate. Even severe constipation may necessitate preliminary cystostomy. If the urologist has any doubts whether the patient is a good surgical risk, prostatectomy should be carried out in two stages. The presence of a large diverticulum necessitates its removal at the same time as the cystostomy is performed. Mention has already been made of the importance of preliminary cystostomy in toxic myocarditis.

**Technique of preliminary suprapubic cystostomy**—By this minor operation it must be the aim of the surgeon to produce little scar tissue and place the opening in the bladder in such a position as to make the subsequent prostatectomy as easy as possible. Much scarring is avoided by preventing the escape of urine into the prevesical tissues and only exposing a sufficient area of the anterior bladder wall to allow the tube to be inserted in the correct position.

If the bladder has to be explored this is not always possible but in a simple cystostomy the opening can be made watertight.

The technique consists of distending the bladder under local intravenous or gas oxygen anaesthesia and then making an incision about 3 in. long immediately above the pubis with the patient in the Trendelenburg position. The sheath of the rectus is incised and the two muscles separated. With the finger the prevesical tissues are pulled upward and the anterior wall of the bladder exposed.

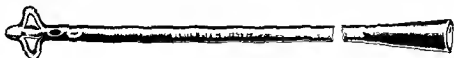


FIG. 43  
A Malcote catheter

A trocar and cannula large enough to take a No. 30 Charriere self-retaining, angular tube (by preference Malcote type) is then plunged through the bladder wall in a downward direction towards the vesical base and midway between the pubis and apex of the bladder. The position of this opening is

important for if too near the pubis the tube causes pain by rubbing against the prostate and if close to the apex of the bladder the subsequent dissection of the abdominal wall needed for prostatectomy opens the peritoneal cavity. Be sure that the point of the trocar is really sharp otherwise there is a tendency for the instrument merely to push the tissues before it instead of penetrating them.

On withdrawal of the trocar fluid will escape through the metal tube but the bladder must not be allowed to empty itself until the operation has been completed. Therefore quickly place a finger over the opening of the cannula until ready to insert the angular tube. The latter with its mushroom end is kept on the stretch with a long metal introducer and is then passed down the cannula into the bladder. Pull the cannula out of the wound with the angular tube still fully stretched then remove the introducer. The angular tube thus fits snugly into the opening in the bladder.

As the prevesical space has not been interfered with by dissection there is no danger of cellulitis. The burying of catgut in the abdominal wall increases the amount of scar tissue. Two through and through silkworm gut sutures are sufficient to bring muscles and skin together and another is needed to stitch the tube to the skin. On no account plug the distal end of the tube. The flow of urine must not be interfered with in any way and should be allowed to pass into a urinal between the legs or one fixed to the side of the bed below the level of the base of the bladder. This is important for siphoning. Encourage the patient to drink freely. Irrigation of the bladder is necessary twice daily to prevent the accumulation of phosphates at the base of the bladder and on the inner surface of the tube. The urine must be kept acid to prevent its decomposition. A good prescription is hexamine (gr v) acid sod phosph (gr xx) inf buchu to the ounce. The mixture to be given three times daily. If the urine cannot be kept acid with these drugs substitute ammon chlor (gr v) for acid sod phosph.

#### THE TECHNIQUE OF ONE-STAGE SUPRAPUBIC PROSTATECTOMY BY THE OPEN METHOD

The surgeon who designs an operation intended to restore an organ to its normal anatomical and physiological states following the removal of diseased tissues which have caused dysfunction must be guided by the following principles: (1) hæmorrhage must be under complete control; (2) sepsis must be avoided; and (3) tissues which have been divided must be brought together again in correct alignment. The anatomical position of the prostate gland and the frequent presence of chronic sepsis have led surgeons to believe that they cannot carry out in this region of the body the technique which embodies the principles taught them from their student days.

No surgeon should leave a raw surface exposed to the secretions or excretions of the body if it can be avoided. His aim is to cover up that surface with Nature's protective agent: i.e. that the wound shall heal by primary union. It had always been thought impossible to completely cover over the raw surface of the bed of the prostate with mucous membrane. Harry Harris (1934) has shown that this view is erroneous. Moreover he has demonstrated the feasibility of reconstructing the internal urinary meatus after it has been damaged by enucleation of the prostate. The technique of suprapubic prostatectomy to be described in the following pages is based on these principles and on the operation devised by Harry Harris with certain important modifications.

## Special instruments needed for suprapubic prostatectomy—1 ILLUMINATED

## BLADDER RETRACTOR—

This is a self-retaining retractor with three fenestrated blades, two lateral and one posterior (1934). To each of these is attached an electric bulb (Fig 244).

## 2 ANTERIOR BLADDER

## RETRACTOR WITH DETACHABLE PROSTATIC SPECULUM

—This instrument is used for retracting the walls of the prostatic cavity and illuminating its floor. In the handle of the retractor is a 3-volt dry-cell battery, and at the tip of the blade are two lamps. A speculum with two movable wings can be attached to the stem of the retractor by means of a screw (Figs 245 and 246). The former should be sterilized by boiling, but the illuminated retractor must be inserted *without the battery* into an antiseptic before use. After immersion for ten minutes the battery is dropped into the handle and the lid screwed on. The instrument is then placed on a sterile towel.

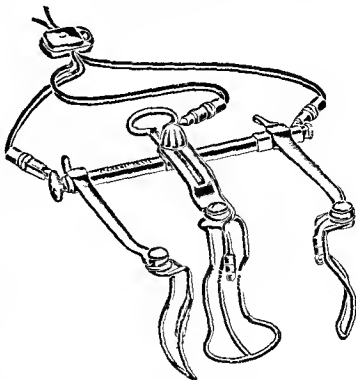


FIG 244

The special illuminated bladder retractor

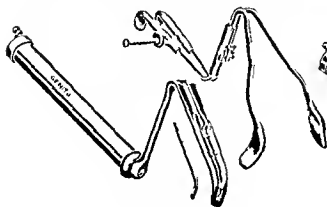


FIG 245

Anterior bladder retractor with detachable prostatic speculum

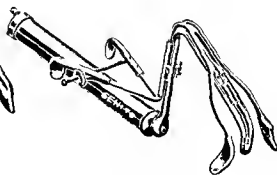


FIG 246

Prostatic speculum attached to anterior bladder retractor

During the plastic part of the operation it is an obvious advantage to preserve hemostasis. The removal of blood by swabbing in such a small space as the prostatic cavity hinders the surgeon and suction in this situation,

though an invaluable method for the bladder has not been found a success. Therefore the blades of the speculum have been so shaped that they compress the vessels which bleed from beneath the lateral flaps surrounding the entrance to the prostatic cavity.

3 THE BOOMERANG NEEDLE AND THREADER (Figs 247 and 248).—The novice will find both these instruments difficult to master and constant

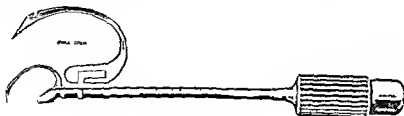


FIG. 247

Boomerang needle

practice with them is needed before they can be used efficiently. A curved threader is more easy to manipulate than a straight one.

4 CATHETER AND INTRODUCER

5 METAL BUTTONS AND GRIPPING FORCEPS

6 CONTINUOUS DRAIN APPARATUS

**Technique and surgical anatomy of suprapubic prostatectomy.**—As soon as the patient has been anesthetized a catheter is passed and the bladder is washed out with 1 in 8000 oxycyanide of mercury or hypertonic saline. A

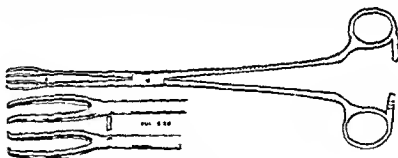


FIG. 248

Special instrument used for threading boomerang needle.

few cases have been recorded of mercurial poisoning following the use of oxycyanide of mercury as a lotion. The organ is then distended with about 10 oz. of this solution after which the catheter is withdrawn. The surgeon proceeds to dissect out the vas deferens immediately below the external abdominal ring and divide it. Beneath the skin of the scrotum the vas is isolated from the other constituents of the cord and held firmly with the finger and thumb. An incision 1 in. long is made in the skin immediately over the vas and the duct pulled out of the scrotum with toothed forceps. When dividing the vas care must be taken not to injure one of the veins of the cord in order to avoid the formation of a scrotal hematoma. On the left side in particular a vein may be divided in mistake for the duct. The object of division of the vas is to prevent epididymo-orchitis. In patients who have submitted to pre-operative bladder drainage by a tied-in catheter vesiculitis



is common. A persisting vesiculitis is sometimes the cause of post prostatectomy obstruction. There is no need to ligature the divided ends of the vas deferens for the lumen is rapidly sealed by scar tissue. The cord is pushed back into the scrotum and the skin wound closed with two catgut sutures (Fig 249). The patient is now

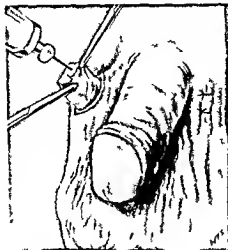


Fig 249

A drawing to show the vas deferens exposed and divided in the upper part of the scrotum. A hypodermic needle has been inserted into the upper end for irrigation of the seminal vesicle with 1 in 80 carbolic acid. The spraying of the prostatic cavity with sulphamidale and penicillin now renders this part of the technique unnecessary.

placed in the Trendelenburg position and the surgeon proceeds to expose the bladder by a subumbilical incision. The incision should extend from the umbilicus to the pubis. Having divided the rectus sheath and separated the two muscles the operator passes his two fingers beneath the pubis and pulls the prevesical tissues towards the umbilicus. By this manoeuvre the anterior wall of the bladder is exposed to view being recognized by the strands of muscle fibres and the large veins on its surface. Two holding stitches are inserted into the anterior bladder wall on either side of the middle line and held taut while the fluid contents are evacuated by plunging into it a special two way trocar and cannula. To one way of the trocar is attached a long rubber tube which drains by suction into a receptacle on the floor.

By this method the abdominal wall escapes contamination. On withdrawal of the trocar and cannula the bladder opening is enlarged both towards the pubis and the apex.

Before the surgeon proceeds with enucleation of the prostatic mass he should visualize with the illuminated anterior retractor the interior of the bladder. This will enable him to observe if any small calculi are resting on the bladder base or the presence of a diverticulum or even of a papilloma. The appearance of the internal meatus is always instructive as an aid to the understanding of the causes at work which produce retention. With patients in whom a large amount of residual urine is present the internal meatus may have been pushed forward so far by the adenomatous growth that it is close up to the anterior wall of the bladder. The pathological mass of adenomatous tissue is then enucleated from within the prostatic bed by the intra urethral method. The finger is inserted into the internal meatus and the mucous membrane is ruptured. The finger is swept round the tumour, which is easily separated from the surrounding glandular tissue (Figs 250 and 251). The urethra is then fractured as near to the verumontanum as is possible. The amount of urethra left behind proximal to the triangular ligament is dependent upon the extent of the growth. If the whole of the prostatic portion is surrounded by adenomata the fracture occurs at the point where the urethra passes through the triangular ligament. If the main mass is intravesical, a considerable length of prostatic urethra can be left behind.

The surgeon after the pathological mass has been removed then inserts into the bladder the special illuminated retractors to each fenestrated blade of which is attached a small electric lamp. With the aid of these three lamps the interior of the bladder is so well floodlit that a perfect view is obtained of every detail excluding of course the prostatic cavity. After removal of any

clots which have collected in the operation area the illuminated anterior

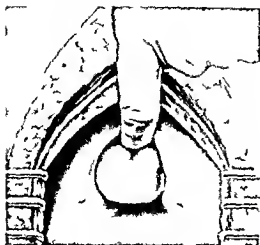


FIG 250

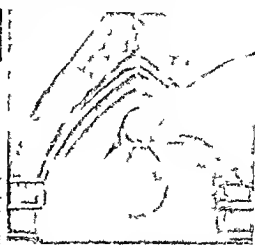


FIG 251

These drawings show the position of the enucleating finger. In Fig. 250 the finger has been inserted into the internal meatus as in Fig. 251 it has broken through the mucous membrane to reach the line of cleavage between the pathological mass and the prostate tissue.

retractor together with the prostatic speculum is inserted into the prostatic cavity. The blades of the speculum are now separated so that they not only act as retractors by opening up the entrance to the prostatic cavity but also by their pressure upon the lateral walls function as temporary hemostats (Fig. 252). The prostatic cavity is so well visualized by this instrument that it is possible to see not only the floor of the cavity but also the prostatic surface of the triangular ligament with the protruding torn portion of the prostatic urethra (Fig. 252).

The trigonal flap of the mucous membrane is now stitched to the mucous membrane of the urethra. If this is not feasible because of the extent of prostatic urethra removed by enucleation the flap is stitched as near the triangular ligament as is possible. Always use plain catgut in the bladder sizes No. 1 or 2. The chronicized variety sometimes fails to become absorbed.

The stitching is done with the aid of the boomerang needle. Because of the tendency of the trigonal flap to retract when a Lambert suture is used a special stitch as shown in the illustration is adopted. Care must be taken that the boomerang needle is inserted only through the trigonal flap and the

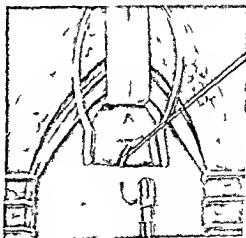


FIG 252

The anterior illuminated retractor with the prostatic speculum is seen in position. The prostatic bed and the torn end of the prostatic urethra are visualized. The boomerang needle has been passed through the mucous membrane of the trigonal flap and the catgut suture attached to it.

superficial tissues forming the prostatic bed (Figs 252 253 and 254) There is no need to insert the needle deeply into these tissues for all that is required

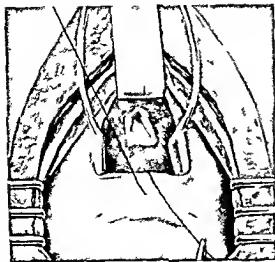


FIG 253

FIG 253—A drawing to show the first manoeuvre of the trigonal flap suture

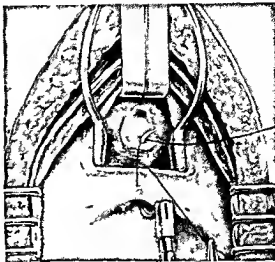


FIG 254

FIG 254 A drawing to show the second manoeuvre of the trigonal flap suture The needle has been passed through the whole thickness of the trigonal flap the prostatic tissue forming the bed and the torn mucous membrane of the urethra The needle is threaded with the flap suture

is to bind down the mucous membrane of the trigone to the floor of the prostatic cavity The criticism which has been made that the point of the needle may

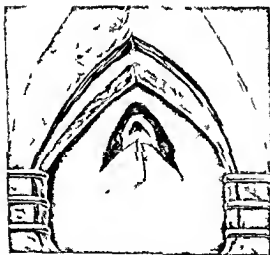


FIG 255

The trigonal flap suture has been tied  
Note that retraction of the flap is impossible

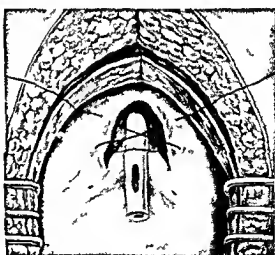


FIG 256

The urethral tube in position after the posterior stitch has been tied The figure of eight suture has been inserted

be inserted too deeply can be justified only if the operator is ignorant of the principles involved in this operation The blades of the speculum are next brought together and with the anterior retractor are removed from the prostatic cavity (Fig 255) As soon as the trigonal stitch has been tied a Latex

rubber catheter No 14 18 Charriere size is inserted by means of the metal introducer through the urethra and prostatic cavity into the bladder. The catheter is now drawn out through the bladder wound (if a Malecot type the mushroom end is cut off) and a thick silkworm gut suture is passed through it immediately distal to the second eye. This is the suture which will retain the catheter in its correct position. Each end should be clipped with a pair of artery forceps. With an insufflator the whole of the prostatic cavity is dusted with sulphanilamide and penicillin powder (5000 units in 1 gramme of sulphanilamide). The operator now proceeds to reconstruct the internal meatus by means of a figure of eight stitch. This is inserted into the mucous membrane and submucous tissues which form the lateral walls of the prostatic cavity on no account should this suture be inserted into the tissues external to the flaps. Fig 256 shows clearly how this suture is inserted. It has a two

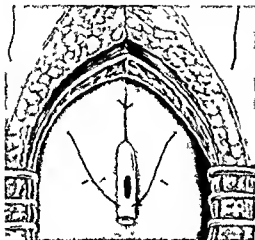


FIG 257

The figure of eight stitch has been tied. A suture has been passed through the catheter lateral walls of the bladder and abdominal wall (The anchoring stitch for the urethral catheter.)

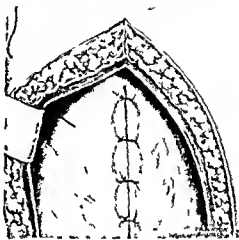


FIG 258

The anterior wall of the bladder sewn up. The anchoring stitch can be seen protruding through the skin of the abdominal wall. The suprapubic tube at the apex of the bladder is not shown in the drawing.

fold purpose (1) reconstruction as already stated and (2) to act as a hæmostat. The reconstruction part of the operation is now complete. The catheter is placed in position so that both eyes are within the bladder. Before the retractors are removed all clots must be swabbed out from the bladder and the new internal meatus visualized. The latter has two striking features: first, it is on a level with the base of the bladder, thus entirely obliterating the post prostatic pouch, and second it closely resembles the appearance of the internal meatus in a normal bladder. The surgeon now proceeds to pass each end of the silkworm gut suture (Figs 257 and 258) holding the catheter in position through the bladder and abdominal walls and out through the skin. Care must be taken not to puncture the deep epigastric vessels with the needle by keeping close to the cut edges of the skin. The next step is to close the anterior bladder wall except for a small opening near the apex through which the angular tube passes. The latter must be made to fit tight in order to avoid leakage. As soon as this part of the operation has been completed the operating table must be tilted so that the patient's head is at a slightly higher level than

his legs. The Trendelenburg position is of greater benefit to the surgeon than to his patient and the operating table must not be kept at this angle a moment longer than is necessary. The tissues of the prevesical space and the anterior wall of the bladder must be dusted with sulphanilamide and penicillin powder. By the use of these antiseptics any infection is avoided. The abdominal wall is now closed in layers care being taken that the cut edges of the rectus sheath are closely approximated as well as the two muscles. If a ventral hernia subsequently forms it is the fault of the surgeon.

The part of the angular tube which is outside the bladder must rest on the abdominal wall and point to the side of the bed where the continuous-

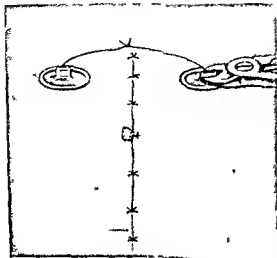


FIG 209

A drawing to show the abdominal wound sewn up and the metal buttons which immobilize the silkworm gut suture. The latter holds the urethral catheter in its correct position. The position of the suprapubic tube is indicated by a rubber wax.

drip apparatus is situated. It is advisable to stitch it to the skin in the region of its angle with a silkworm-gut suture. Lastly, the ends of the suture (which maintains the catheter in its correct position) are immobilized by metal buttons of the Emesay pattern (Fig 259).

**Post-operative treatment** — Before the patient's return to bed the bladder should be irrigated with any weak antiseptic lotion at 90 degrees Fahrenheit through both tube and catheter. If hæmorrhage has been efficiently controlled the return of fluid will be scarcely blood-stained. Continuous - drip vesical irrigation must be commenced at once. The lotion should be electrolytic sodium hypochlorite (1 drachm to the pint) at a temperature of 90 degrees Fahrenheit. The necessity of using a solution of not more than 90 degrees

Fahrenheit is apparent if one realizes how sensitive the bladder mucous membrane is to heat, also fluid of a temperature of above body heat is likely to increase the oozing of blood. Rarely the bladder mucous membrane shows intolerance to sodium hypochlorite by attacks of strangury. Saline must then be substituted.

It is the duty of the surgeon to satisfy himself that the apparatus is working efficiently. All glass connections must have the same lumens as the tubes to which they are connected. Care should be taken that there is no pull on either the suprapubic tube or the catheter. It is advisable to strap the glass tube attached to the catheter to the skin of the thigh, and by means of rubber tubing run the lotion from the bladder into a bottle on the floor beside the bed. A nurse can thus watch the drip without disturbing the patient. If the lotion does not run satisfactorily through the catheter the flow can be reversed so that the bladder contents flow out by way of the suprapubic tube. Sometimes a small clot will block one or other tube. This can be washed out by means of a metal syringe. The drip treatment must be without cessation for four days and nights. At the end of this time, provided the urine is clear, the suprapubic tube is removed and all urine then allowed to escape by the catheter.

Thereafter the bladder is washed out twice daily with the sodium hypochlorite care being taken to inject not more than 2 oz at a time. On the other hand if at the end of four days the urine is still blood stained or dirty the continuous drip treatment should be continued for at least another forty eight hours. Throughout this period forced diuresis is indicated the patient being encouraged to drink large quantities of water. Hexamine grs 5 and ammonium chloride grs 5 must be given 4 hourly to maintain the acidity of the urine throughout the period of convalescence. The bowels must be opened the third morning after the operation by giving 2 drachms of cascara evacuant the previous evening followed by a soap and water enema ten hours later. Morphia for the relief of pain may be given for the first few days but the general condition of the patient usually benefits by reducing drug treatment to a minimum. Daily bowel actions with the aid of enemata are necessary for the first week.

On the twelfth day the catheter is withdrawn by dividing the silkworm gut suture beneath one of the buttons. This suture is then pulled out with the aid of the other button. It is instructive to note how little discomfort is caused by the presence of a soft rubber catheter in the urethra maintained in position by the technique which has just been described. The catheter in the urethra stripped to the penis is a form of torture which is entirely dispensed with by this method of fixation. It is an important step forward in adding to the patient's comfort during post operative convalescence. The degree of urethritis is negligible and the catheter so long as the silkworm gut suture is intact never alters its position however much it may be dragged on. Directly the catheter is removed the patient passes urine by the urethra.

For some days micturition is about two hourly but by the time the patient leaves the hospital on an average about the twenty-eighth day it has become four hourly. The abdominal wound should be securely healed within three weeks of the operation in many cases the healing is complete by the thirteenth day. The extent of urine leakage after the removal of the angular tube is so slight that the dressing need only be changed once a day.

In every case of prostatectomy no matter what may be the technique the urine on the patient's discharge from hospital contains pus and bacteria. The reason for this infection so long after the operation is easily explained. An investigation was made by J. E. Semple and the writer (1934) with the aid of the posterior urethroscope of the changes which take place in the prostatic bed from the fifteenth day after the operation until the sixth week (Figs 260 and 261). It was found that the healing process in this region was extremely slow. Even at the end of the sixth week there was still non union between the mucous membrane of the trigone and that of the urethra. So long as a raw surface persists there must be pyuria.

From two to three months therefore elapse before the tissues at the neck of the bladder become normal. If there has been no attempt to cover up the raw surface of the prostatic bed by mucous membrane as in the blind or Freyer operation this healing process cannot be complete for at least four to six months. This accounts for the fact that if post prostatectomy obstruction is going to occur it does not manifest itself for about six months following removal of the diseased prostate.

The large majority of patients are discharged from hospital long before healing is complete at the internal meatus. Posterior urethroscopic examination demonstrates quite clearly the importance of bringing the mucous membrane of the base of the bladder as near to the torn end of the prostatic urethra as is possible. The more extensive the area of raw surface uncovered at the

end of the operation the greater will be the formation of scar tissue, and therefore contraction at the bladder neck.

### THE TECHNIQUE OF TWO-STAGE PROSTATECTOMY

Owing to the formation of scar tissue around the suprapubic sinus the exposure of the anterior wall of the bladder and its mobilization requires careful dissection. As in the one-stage operation the patient is placed in the Trendelenburg position and the surgeon then proceeds to excise the scar tissue of the abdominal wall. He will be well advised to commence his incision about 2 in. above the scar so as to be able to expose the extraperitoneal tissues easily. He can then by raising up the recti muscles with his fingers, cut through the tissues immediately above the sinus without buttonholing the peritoneum. With one finger in the fistula he elevates the anterior wall of the bladder. The scar tissue round the fistula is then incised and the peritoneum together with the prevesical tissues carefully peeled off the muscular coat of the bladder wall. By this dissection the bladder is mobilized. The difficulties of the operation are much enhanced if the bladder fistula is in the wrong position. Should the opening have been placed close to the apex of the bladder it is difficult to avoid opening the peritoneal cavity. Again, if the fistula passes close to the pubis and opens into the bladder adjacent to the prostate, it becomes almost impossible, after the prostatectomy, to be able to close the anterior wall without leaving a small hole behind the pubis. Urine leaks through this opening and causes pelvic cellulitis. There is no excuse for making the cystostomy opening in these positions.

When the bladder wall has been mobilized holding sutures are inserted. The technique is then the same as in the one stage operation. Convalescence owing to the slow healing of the abdominal wall, takes longer, and with the removal of the suprapubic tube, leakage of urine may occur for a week or ten days. It must be understood that a reconstruction operation can only be performed if there is adequate exposure of the bladder and also adequate visualization of the prostatic cavity. For both special retractors and powerful illumination are needed. In a few cases of a second stage prostatectomy the bladder is so contracted that it is impossible to insert any form of retractor which will give sufficient exposure of the internal meatus without tearing the postero superior wall of the bladder and making an opening into the peritoneal cavity. It is obvious that in this class of case a reconstruction operation is out of the question.

The technique must be that of Freyer. Mobilization of the bladder is unnecessary, but the scar tissue around the fistula must be excised and the opening enlarged by incising the anterior wall between it and the pubis. The surgeon then inserts his forefinger into the bladder and enucleates the prostate.

### THE COMPLICATIONS OF SUPRAPUBIC PROSTATECTOMY

1. **Vesiculitis**—Inflammation of the seminal vesicle may occur either from a tied in catheter during preliminary drainage of the bladder or from infection at the time of prostatectomy. The indications of its presence are persistent fever of about 99 degrees to 100 degrees throughout the immediate post-operative period and tenderness of the vesicle on rectal palpation. Once the infection has established itself eradication is very difficult, but spontaneous cure eventually takes place.

Vesiculectomy has been suggested at the same time as the prostatectomy. This would increase the shock of the operation, which is not to be recom-

mended With the improvement in both aseptic and antiseptic methods this complication is becoming uncommon

2 Cellulitis of the spermatic cord—This condition is a sequel of vesiculitis and results from the spread of infection along the lymphatics of the vas deferens—if the latter has not been divided orchitis occurs Its presence is manifested by tenderness on palpation in the groin and the formation of a swelling at the external abdominal ring Rarely a small abscess forms at the point of division of the vas It is not a serious complication and the inflammation resolves without the necessity for special treatment

3 Scrotal cellulitis—This is due to lack of surgical cleanliness when the vas deferens is divided It is often mistaken for epididymo orchitis Treatment consists in giving support to the scrotum and if pus forms evacuating it through an incision It is a preventable complication

4 Reactionary hæmorrhage—In the Freyer or blind operation hæmorrhage immediately after the prostate has been enucleated can be controlled either by packing the prostatic cavity with gauze soaked in acriflavine and paraffin or by a Pilcher's bag Both methods are effective in controlling bleeding but are very crude The correct control of hæmorrhage due to laceration of blood vessels is by ligature which is the technique of the reconstruction operation If the prostatic cavity is packed with gauze the free end is brought out of the wound alongside the suprapubic tube Its removal on the second or third day usually requires intravenous or gas oxygen anaesthesia The presence of gauze in the prostatic cavity promotes sepsis The Pilcher's bag contains two rubber connections one of which is passed through the urethra and attached to the thigh while the other is brought out through the suprapubic wound When in position the bag is filled with either water or air It is retained in the bladder for four or five days This bag has two grave disadvantages (1) the sphincter urethræ muscle may be overstretched by the tension on the urethral tube resulting in incontinence and (2) if the bag is overfilled with water or air the penis becomes gangrenous from pressure on the dorsal vein The bag when collapsed is removed from the bladder by pulling it out through the suprapubic wound If the modified Harris technique has been carried out efficiently reactionary hæmorrhage does not occur The bleeding in the prostatic cavity after enucleation comes from vessels beneath the torn edges of the mucous membrane and these are ligated by the figure-of-eight stitch

5 Secondary hæmorrhage—So long as it remains impossible to eliminate sepsis secondary hæmorrhage will occasionally occur The larger the raw surface in the prostatic bed the more likely is the complication to take place When the floor of the prostatic cavity is completely covered by mucous membrane there is small risk of secondary hæmorrhage It occurs from twenty four to forty eight hours after removal of the urethral catheter and if not severe can be controlled by reintroduction of the catheter and irrigation with strong electrolytic sodium hypochlorite

Should the patient pass clots and complain of pain over the bladder a tube of large size must be inserted through the abdominal wound into the bladder under anaesthesia At the same time all clots must be evacuated The bladder should then be thoroughly irrigated with electrolytic sodium hypochlorite at body temperature This must be followed by a blood transfusion which can be repeated at intervals of twenty four hours if oozing continues The drip method of giving blood in these cases is not advised owing to the necessity for immediate restoration of the normal volume of blood

In order to avoid delay all patients should be grouped before operation



Secondary hæmorrhage is a serious complication and the surgeon must act quickly if he is going to save the patient's life. Morphia for the relief of pain is useless unless all clots have been removed from the bladder. It is a waste of time to practise conservative measures such as irrigation through a catheter, if the patient is suffering from bladder spasms. The suprapubic tube must not be removed until the urine has been free of naked-eye blood for at least three days. Its early removal often results in another hæmorrhage. The key to success in the treatment of this most serious of all complications is free drainage of the bladder and blood transfusion before the patient becomes exhausted by pain. With the introduction of such new antiseptics as electrolytic sodium hypochlorite, urea formic iodide, the sulphadiazine drugs, and penicillin it may be safely asserted that bladder sepsis is completely controlled, with the exception of those cases in which chronic pyelonephritis of bacillus coli origin is present. Secondary hæmorrhage need not therefore be regarded as a likely complication.

6 **Pelvic cellulitis**—This is due to the trickling of infected urine from the prevesical space into the cellular tissue around the bladder. If severe the prognosis is desperate. Its manifestations are high fever and œdema of the tissues around the pubis. This complication can be prevented by careful stitching of the anterior wall of the bladder immediately behind the pubis, delaying the prostatectomy of a second stage operation until all the sepsis in the bladder and abdominal wall has subsided and above all thoroughly dusting the prevesical tissues with sulphanilamide powder and penicillin.

7 **Acute renal sepsis**—Cases in which there has been prolonged back pressure prior to operation are liable to develop renal sepsis during convalescence. The attack commences within a few days of the removal of the catheter and may be ushered in by a rigor, followed by high fever. Treatment consists in draining the bladder by a tied-in catheter and continuous intravenous drip of 3 per cent sodium sulphate. The infection is due to the B. coli. No known drug can destroy this organism. Drainage, diuresis and diaphoretics are the only effective remedies.

8 **Persisting suprapubic fistula**—This troublesome complication may be due to —

(a) *Failure to close the anterior wall of the bladder behind the pubis combined with mild pelvic cellulitis*—Treatment consists in drainage of the bladder by a tied-in catheter.

(b) *Chronic renal sepsis*—This is associated with a second-stage operation and may necessitate enlarging the suprapubic sinus and draining the bladder for two or three months. The surgeon has committed an error of judgment in advising prostatectomy in these cases.

(c) *Attachment of the mucous membrane of the bladder around the suprapubic fistula to the posterior aspect of the recti muscles*—This is due to an error of technique when closing the anterior wall of the bladder. The cut edges of mucous membrane must be covered by the muscle coat of the bladder when stitching. Treatment consists in excising the suprapubic fistula, freeing the bladder mucous membrane from the rectus muscle and inverting it with catgut sutures. The bladder is drained with a tied-in catheter for ten days.

9 **Suppurative urethritis**—Some patients show intolerance to any catheter retained in the urethra for more than three days. The complication is a rare one but when it occurs the catheter must be removed immediately to avoid the formation of perineurethral abscess.

10 **Incomplete incontinence**—This is due to overstretching the sphincter urethræ from prolonged catheter drainage, or the use of too large a catheter.

The incontinence may be troublesome for two or three months but gradually the sphincter muscle recovers its tone. No special treatment is needed but a rubber urinal may have to be worn for a few weeks. Electrical treatment has a psychological value.

**11 Post-prostatectomy obstruction**—Complete division of the urethra is an essential part of a prostatectomy no matter from which route the enucleation takes place but it is a flaw in the operation. A rupture of the urethra by design is as serious as one by accident. Urinary dysfunction from the resulting traumatic stricture may not manifest itself for two to three years after the operation. It is remarkable that this disability does not follow prostatectomy more frequently. It is a rare complication of the reconstruction operation for adenomatous disease. In 274 consecutive cases only three suffered from this disability. It is due to excess of scar tissue at the point of union of the bladder mucous membrane with that of the urethra.

A persisting vesiculitis is sometimes responsible for narrowing of the urethra but a more frequent cause is suppuration in the prostatic bed during the post operative convalescence. The recent use of electrolytic sodium hypochlorite by the continuous drip method during the first week after operation has minimized the danger of the occurrence of this serious complication. Rough handling of the urethra during insertion of catheters is another cause of post prostatectomy obstruction but such carelessness is indefensible.

An occasional cause in the Freyer operation is the failure of the bladder mucous membrane to adhere to the prostatic bed. This cannot occur in the reconstruction technique. The obstruction may be so slight as to need only the occasional dilatation of the stricture but in the severe form transurethral resection of the scar tissue is indicated.

**12 Uræmic peritonitis and ileus**—This condition is a very serious one. The abdominal distension commences about the second day after operation and unless treatment is immediately successful the prognosis is grave.

Pitrescin or prostigmin (1 c c) must be given subcutaneously followed an hour later by a turpentine enema. If prompt relief is not obtained this must be repeated four hours later. An intravenous saline drip is also helpful. When this condition occurs during preliminary suprapubic drainage it has been mistaken for intestinal obstruction. The history of renal damage should prevent the surgeon from falling into this error.

Sometimes after the distension has been relieved for a few hours there is a recurrence when the treatment will have to be repeated.

The voluntary passage of flatus per anum is not necessarily an indication that the complication has been overcome. The reliable guide is the gradual reduction in the size and tenseness of the abdomen.

**13 Pulmonary embolism and thrombosis**—These are complications common to any operation. Recently heparin has been given with good results provided the treatment is instituted immediately the diagnosis is made. The drug is given intravenously at four hourly intervals in doses of 150 and 100 milligrammes. An advantage of this treatment is that the patient is allowed to move freely in bed (Bauer 1946).

#### THE RESULTS OF SUPRAPUBIC PROSTATECTOMY BY THE RECONSTRUCTION TECHNIQUE

An analysis of the results of this operation is based on a total of 274 consecutive cases. Eighty five of these were operated on at a municipal hospital and with few exceptions were poor surgical risks. Of this number 13 died

thus giving a mortality rate of 15·3 per cent. At St Peter's Hospital, for stone—a voluntary hospital—there were 86 cases with 7 deaths, a mortality rate of 8 per cent. In private practice 103 patients were submitted to this operation and there were 9 deaths, a mortality rate of 8·93 per cent. The large majority of these cases were operated on before the general use of the new antiseptics which have resulted in the complete control of urinary sepsis with the exception of chronic pyelonephritis of bacillus coli origin. The fall in the mortality rate is referred to at the end of this chapter.

A careful record has been kept of the post-operative convalescence and results in 103 private patients. The average age was 67 years, the youngest 54 and the oldest 80. Of the 9 deaths, 4 died of a urinary complication, namely, pyelonephritis and 5 of non urinary complications. Of the latter, 1 died of diabetic gangrene, 3 from ulcerative colitis and the 5th from hæmorrhage due to duodenal ulcer. The case which died of diabetes was only operated on because of a persisting hæmorrhage from the adenomatous prostate. The only hope of saving the patient's life was to remove the cause of the bleeding, but neither insulin nor any other treatment was of any avail in controlling the diabetes, and the patient succumbed to the effect of gangrene of the lower limbs.

Ulcerative colitis accounted for 3 deaths, 2 of which were confirmed by post-mortem findings. The third patient had lived most of his life in the tropics.

The notes of the 2 cases on which post-mortem examinations were made are worthy of record.

One was aged 54 and the other 58, the former having complete retention and the latter 6 oz of residual urine. In both patients the renal function tests clinical and laboratory, were satisfactory. In the patient aged 54, the mass enucleated was the size of a tangerine orange and in the man aged 58 no larger than a golf ball. Both complained of flatulence and abdominal discomfort twenty-four hours after operation. On the second day both patients had bowel actions which continued at intervals of one to two hours, until death took place on the fifth and seventh days respectively. To the naked eye the stools of the first patient contained neither blood nor mucus, but these were present in the faeces of the second case. All the well-known remedies including blood transfusion were unavailing. Modern sulphonamide enemata treatment was not in use. The post-mortem examinations in both cases revealed healthy kidneys. There was extensive ulceration of the cæcum and the whole of the colon. In the patient aged 54 the spleen was twice its normal size. Throughout the illness of each the temperature remained subnormal.

The patient with a duodenal ulcer had an attack of hæmatemesis at the end of the prostatectomy operation while waiting to be removed from the operating table. He continued to bleed from both mouth and bowel for two days. Blood transfusion was of no avail. He had suffered from several attacks of retention accompanied by indigestion but neither physician nor surgeon suspected the presence of a lesion other than that of the prostate.

**Results of operation in one stage.**—Seventy-five patients were submitted to prostatectomy in one stage. Forty-nine of these had an uneventful convalescence free from any complications. The average time of healing of the suprapubic wound with all urine passed per urethram, was thirteen days. Twenty-six suffered from complications of which 4 died from non urinary diseases and 2 from pyelonephritis. The complications occurring in the 20 cases which survived were (a) secondary hæmorrhage, 7, one of which was

severe Any patient who had visible blood in his urine after removal of the catheter on the twelfth day was considered to have suffered from secondary hæmorrhage (b) vesiculitis with some degree of urethral obstruction 1 (c) scrotal inflammation at point of division of the vas deferens 3 (d) pyelonephritis 2 (e) pleurisy 1 (f) pneumonia 2 (g) thrombosis 1 (h) diverticulum 1 (i) slight incontinence lasting for three months 1 (j) glycosuria 1

**Results of operation in two stages**—Twenty eight patients were submitted to prostatectomy in two stages Twenty three of these had an uneventful convalescence free from any complications

The average time of healing of the suprapubic wound with all urine passed per urethram was 21.3 days

Five cases suffered from complications of which two died from pyelonephritis and one from diabetic gangrene

The complications occurring in the two patients who survived were (a) secondary hæmorrhage 1 (b) severe urethritis 1

### Table of Complications

#### ONE STAGE COMPLICATIONS (75)

	Number of Cases
(a) Secondary hæmorrhage one of which was severe	7
(b) Vesiculitis with some degree of urethral obstruction	1
(c) Scrotal inflammation at point of division of vas	3
(d) Pyelonephritis	2
(e) Pleurisy	1
(f) Pneumonia	2
(g) Thrombosis	1
(h) Diverticulum and cystitis	1
(i) Slight incontinence lasting three months	1
(j) Glycosuria	1
(k) Severe urethritis	0
	<hr/>
	20
Other cases which died	6
	<hr/>
Total number of complicated cases	26
	<hr/>

#### TWO STAGE COMPLICATIONS (28)

Secondary hæmorrhage one of which was severe	1
Severe urethritis	1
	<hr/>
	2
Other cases which died	3
	<hr/>
Total number of complicated cases	5

**Comments**—The few cases of pulmonary complications—only three—are good testimony of highly efficient anaesthesia

There was one case of post prostatectomy obstruction and this was associated with vesiculitis—a septic complication

Sepsis was also responsible for 8 cases of hæmorrhage It is believed that the universal use of electrolytic sodium hypochlorite for continuous irrigation

of the bladder reduces the risks of septic complications to a minimum. In this series of 103 cases it has only been used in the last 30 patients, and of these only 1 had secondary hæmorrhage. It is also possible that vesiculitis will be avoided by the use of this and other antiseptics. The number of deaths from non urinary complications is significant, namely, 5 out of a total of 9.

These findings clearly demonstrate the importance of careful examination of all the systems of the body before a patient is submitted to prostatectomy. The total number of deaths in 274 cases taken from all classes of the population is 29—a mortality rate of 9.2. At the present time the large majority of those who enter a municipal hospital in the London area and are submitted to prostatectomy must be considered poor surgical risks. A further series of 73 cases operated on in such an institution in the past two years shows an extraordinary decrease in the number of fatalities, there were only 4 deaths, a mortality rate of 5.4 per cent, whereas in 85 cases treated at the same hospital 5 years ago, the figures were 15.3 per cent. The reason for this striking reduction is not due to any alteration in technique, but to the use of new antiseptics. These have made prostatectomy as safe as any major operation for the elderly.

The post-operative convalescence is noticeable firstly, for the ease with which the patient can be nursed and, secondly, on account of the rapid healing of the suprapubic wound, in the one-stage operation an average of thirteen days, and an average of twenty-one days in the two-stage.

A CLIFFORD MORSON.

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**Pre-operative Treatment**—The patient is usually admitted the day preceding the operation and is put on 8 hourly 1 gm doses of sulphonamide or sulphadiazine and 8 hourly doses of 200 000 units of penicillin. If his blood urea is over 100 at least one day is spent in giving an intravenous drip of about two pints of plasma because most highly uræmic patients are suffering from hypoproteinaemia.

**The Anaesthetic**—To protect the cardiovascular and nervous systems from a sudden lowering of blood pressure an extremely low spinal anaesthesia is essential. Commonly 14 c.c. of Nupercaine is injected with intensive barbotage between the third and fourth lumbar vertebrae. When analgesia reaches a point midway between the symphysis and the umbilicus the patient is tilted with the feet downwards so that the analgesia never reaches the umbilicus—a flicker of the rectus femoris on attempting to raise the leg and movement of the feet should always be present. At the same time an intramuscular injection of 1 c.c. of methedrine or its equivalent is given. A serious fall of blood pressure must never occur in old men; otherwise cardiovascular and nervous disturbances such as thrombosis may occur immediately or subsequent to the operation. An excessive fall of blood pressure in the presence of cardiovascular disease may be irreversible and in any case it always results in a post operative diminished renal output. Where the latter occurs the blood urea instead of steadily falling from the moment of the operation has a post operative rise which may be fatal. The blood pressure is taken both before and throughout the operation and at the end of the operation it must certainly not be more than 30 mm. below that at the beginning. The blood pressure must be high so that most of the bleeding can be seen and stopped and at the end of the operation the Trendelenburg position must be slowly not suddenly changed to the horizontal. Too much emphasis cannot be laid upon this blood pressure question. Deaths after this operation are usually due not to uræmia but to neuro cardiovascular disturbances. After the operation the patient is invariably kept in the horizontal position and not with the foot of the bed raised in order to keep the citrate solution in the prostatic bed.

If the pre operative systolic blood pressure is unduly low e.g. 85 mm. the surgeon begins by gently making a horizontal incision possibly with the help of a local anaesthetic when full anaesthesia has reached the groins. With such a low initial blood pressure there ought to be no descent at all; the pressure ought rather to be higher at the end of the operation than at the beginning. At any time if necessary 0.25 c.c. of intravenous methedrine can be slowly injected.

General anaesthetics are never used because they have led to cardiovascular lung and cerebral sequelae but psychological shock must be avoided.

**The Operation**—The operation is conducted throughout with absolute asepsis, strict towelling and changes of instruments, gowns and gloves where necessary. The more purulent the urine the more scrupulous should be the asepsis.

The bladder is opened and thoroughly inspected. If there is doubt about a concomitant or causant intraperitoneal lesion the abdomen is fully explored before a septic bladder is opened. The peritoneum need not be closed until the end of the operation. A sterile soft bougie with a long nylon thread attached is then passed through the urethra retrogradely and pulled by an assistant until about six inches of the thread are left lying on the towels at the lower end of the wound. A clip is placed on the same nylon thread at the external urinary meatus by the unsterilized assistant; this prevents the

the urethra throughout the operation (Fig 261) The final indwelling tube is 5 mm or 6 mm in diameter and the wall is 1 mm thick Two holes are cut in the bladder end of this tube so that one lies in the prostatic bed and the other and also the end of the tube lie in the bladder itself Traction on the thread at the end of the penis places this final tube in position

The incision in the bladder wall is then closed and it is very important that this closure should be made in three layers the first is a continuous one of No 0 catgut running down to but not through the mucous membrane When it has closed the bladder it is laid aside and four or five interrupted sutures should be placed between the turns of the continuous one, still not

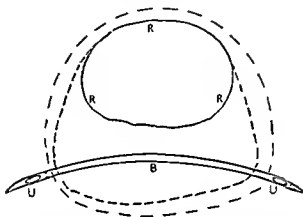


FIG 261A

Diagram to illustrate lines of excision of bladder wall and trigone after freeing the prostate from its bed  
R Rim of entrance into prostatic cavity U Ureters  
B Inter ureteric bar Line of section with diathermic needle indicated by

- — — — — in the benign hypertrophy
- — — — — in the suspected cancer
- — — — — in the proved cancer

penetrating the mucous membrane of the bladder The continuous suture should then be picked up and should act as a covering suture like the Lembert so commonly used in intestinal work The abdominal wall is then closed and since the prevesical space is usually large on account of the fact that there will no longer be any residual urine a tube is inserted to drain it for twenty four hours A suture through the prepuce and the tube holds it in position reinforced by elastoplast Any other method of retaining this urethral tube may lead to suprapubic leakage

The bladder is then emptied through the tube to see that clot is not present and 2 to 10 oz according to the original size of the bladder of 5 per cent sodium citrate is left in and a spigot applied

Vasectomies are only essential when the urine is purulent but it is probably wiser to do them in all cases During the operation other procedures such as removal of vesical diverticula stones and growths cure of hernias hydroceles appendicitis or cancer or diverticulitis of the pelvic colon can be performed with impunity My operation of testicular evisceration combined with vasectomy through a 1 in scrotal incision is done in every case of suspected cancer

**After-treatment**—The bladder is emptied by removing the spigot two hours later. If there is clotting it is better to inject a few ounces of citrate for another two hours but any sodium citrate used in a ward must contain formalin (1:500). If during the subsequent 24 hours the nurse decides that the urethral tube is blocked she is entitled to inject half an ounce of citrate-formalin solution to clear the tube. If the patient complains of a desire to pass urine or has spasms or passes urine round the tube and he cannot be made comfortable by mild suction—not injection—then the tube must be removed however soon after the operation. The lumen of the urethra is greater in the absence of a tube. The sooner the urethral tube is removed the better because it is a high road for sepsis although the urethral tube is connected by a sterile tube into an aseptic Winchester. Usually the tube is removed on the second day and the patient henceforth passes urine normally unless he is of a nervous type when carbachol morphia and hot baths are tried. Only as a very last resort must a catheter be passed.

The urine must be kept acid and every nurse must be acid minded. If it ever becomes dubiously neutral or definitely alkaline the possible infection is immediately attacked with penicillin, sulphonamides, mandelic acid, ammonium chloride, acid sodium phosphate and hexamine. All armamentaria should come into action immediately.

The patient gets up every day after the operation and usually goes for a walk one week later. The sealed wound is dressed only once on the tenth day when the sutures are removed.

The patient can go home ten days after the operation but the prostatic bed will not be fully epithelialized for a further ten to twelve weeks as shown by the cystoscope.

He returns for inspection only if he passes urine more than once at night three months after the operation.

During these three months of healing autogenous infection rarely occurs if it does the sequelæ need cause no anxiety. An excessive fluid intake, sulphonamides and perhaps penicillin will resolve the lesions in a bladder with perfect drainage and complete emptying.

**Results**—Post operative increase of uræmia is the result of infection. Consequently all patients who have any chance of surviving a few post operative days are accepted. If nothing is done these patients have only a short time to live. Cases where suprapubic drainage or catheterization have been established for years are accepted. Nevertheless if the above anæsthetic and operative procedures are faithfully carried out the mortality without previous instrumentation should be under 4 per cent. With instrumentation unless a long interval has elapsed it will be much higher.

The most important result of this aseptic procedure is that the expectation of life will be markedly prolonged because the old man has not passed through a septic ordeal. Further it has been shown that if serial or multiple sections are made at least 17 per cent of all prostates removed are malignant therefore it behoves us to remove the prostate widely.

WILSON H. HEY



## CHAPTER XLI

### RETROPUBIC PROSTATECTOMY

**A**LTHOUGH excellent results are obtainable by each of the commonly practised operations for prostatic obstruction, few can be satisfied with the position in general. The multiplicity of procedures advocated, each vehemently supported by its protagonists and equally strenuously criticized by others suggests to the impartial observer that the prostatic millennium is far from realization.

After a personal experience of more than 1,500 transurethral prostatic resections both by the endothermy loop and the cold punch, several hundred Freyer enucleations more than 150 Harris prostatectomies, and a score or so of perineal and sub pubic interventions I remained unconvinced that betterment was impossible.

As I see it the ideal operation for prostatic obstruction should secure the removal not only of the whole of the obstruction but of all potentially obstructing tissue with a low mortality, an easy and short convalescence, and have a minimum of complications and perfect functional result in a high proportion of cases. Each of the classical procedures falls far short of this ideal in one or more respects.

The retropubic extravesical approach I first employed in August 1945, unaware of analogous though essentially different operations previously performed by van Stockum, Maier and Casper and Jacobs. The ease of the approach and the easy convalescence soon convinced me of its wide applicability. I have to date performed the operation more than 200 times and I now advocate its use in the great majority of cases of prostatic obstruction requiring operative intervention. I still employ the transurethral approach in most fibroses.

The approach has been used in all types of simple enlargement in median bar and other types of fibrous obstruction, prostatic abscess, calculous prostatitis and early carcinoma of the prostate. It may readily be employed as a secondary procedure after a preliminary cystostomy.

The technique is varied according to the nature of the obstruction to be dealt with. That now employed when dealing with the various forms of benign enlargement or 'adenomatous' hypertrophy is as follows —

Where the general condition is good, renal function tests adequate, urine uninfected, and cardiovascular system reasonably satisfactory, no preliminary drainage either by indwelling catheter or cystostomy is used and the operation proceeded with forthwith. Where urinary infection is present but renal function good a short course of sulpha drug therapy will usually suffice to clear up the infection. Where renal function is impaired an indwelling urethral catheter will improve the condition sufficiently in 10–14 days in most cases to warrant a one stage prostatectomy. In more advanced renal impairment this preliminary urethral drainage will be inadequate and a cystostomy will be necessary. Other cases requiring a cystostomy are those in which a large chronic retention has been present with overstretching of the vesical musculature and those harbouring a large vesical calculus usually infected. Experience

has shown that in only 5 per cent of cases approximately is a preliminary cystostomy necessary

The operation is thus conducted for any form of simple enlargement —

Where cysto urethroscopy has not been carried out previously as a diagnostic measure this is performed as a preliminary part of the operation after the patient has been anaesthetized. The author's wide angled vision cysto urethroscope allows not only a thorough inspection of the bladder to rule out the presence of diverticula papillary tumours and the like but gives an excellent view of the prostatic urethra enabling an exact estimation of the precise nature of the obstructing tissue. The McCarthy panendoscope may be similarly employed but it is inferior for vesical inspection albeit excellent for urethra and bladder base. Where open operation is decided upon the bladder is emptied and the endoscope withdrawn. The operator changes his gloves and gown whilst the assistant carries out the necessary skin antisepticization and towelling. According to preference either a vertical mid line incision  $2\frac{1}{2}$  3 in long commencing below at the upper border of the pubis or a similar length transverse section of the skin is made 1 in above the pubis. In either event the aponeurosis is incised in the line of the skin section and the recti separated in the mid line. To secure adequate retraction of the recti when employing the transverse skin incision the upper and lower leaves of the aponeurosis are separated from the underlying muscle fibres. Bleeding points are secured with haemostats and coagulated. The transversalis fascia is next incised at the lower angle of the wound and the right index finger gently inserted and the pre vesical fat and peritoneum drawn upwards so freeing the anterior surface of the bladder and opening up the retropubic space. The author's self retaining retractor is now introduced the lateral blades spreading the recti. The upper blade is placed in position to depress the bladder and further to open up the retropubic space. Careful inspection of the field is now made and any obvious veins lying superficial to the prostate are grasped with long haemostats divided and coagulated. Small swabs mounted on long sponge holding forceps are employed to clear the anterior aspect of the prostate of adherent fat. Some 12 in of a 4 in gauze roll are introduced with long dissecting forceps into each lateral recess depressing each levator and from the corresponding lateral surface of the prostate. The endopelvic fascia with its contained dense plexus of veins in close apposition to the true capsule of the prostate is clearly seen. The upper limit of the prostate at the bladder neck is now identified by palpation and corresponds with the transverse distribution of veins. Using a long handled scalpel the endopelvic fascia true and false prostatic capsules are incised 1 cm below the bladder neck over the right prostatic lobe (Fig 262). The incision is deepened until the typically white adenoma is clearly visualized. This incision is accompanied by marked venous bleeding and the judicious use by the assistant of a good sucker is important to allow accurate vision. Using long scissors curved on the flat the lower capsular flap is rapidly undermined and seized with a pair of T-shaped capsule forceps. A similar capsular incision is made over the left lateral lobe linking up with that over the right lobe the lower leaf undermined and held by means of a second pair of T-shaped forceps. The upper flap is next seized by a toothed volsellum and drawn upwards so exposing the adenomatous mass. A stay suture is passed through the edge of each capsular flap using a small boomerang needle knotted and the ends held in haemostats. The volsellum is dispensed with. Elevating the lower capsular flap by means of the T forceps the lower limits of the lateral lobes are defined freed by means of the long scissors and the urethra then divided with scissors as far proximally as possible.

The lateral recess packs and T forceps are next removed and the retractor withdrawn. Elevating the lower capsular flap by means of the stay suture the right index finger is insinuated between this structure and the adenomatous mass and the enucleation proceeded with from below upwards. When the adenoma has been peeled from the pathological capsule it will be merely adherent at the bladder neck by a mucosal cuff. The circular fibres at the



FIG. 262

Incising capsule over right lateral lobe

vesical outlet are sponged upwards and the mucosal cuff deliberately sectioned with scissors preserving as much mucosa as possible. The adenomatous mass having thus been removed a temporary pack is placed in the prostatic cavity to control the oozing. The self retaining retractor is replaced, the gauze pack removed and by drawing on each stay suture the prostatic cavity is widely opened up allowing careful inspection for evidence of small adenomata inadvertently left behind. Good illumination and adequate suction is essential at this stage. The cavity should be left perfectly smooth. Attention is now directed to the vesical outlet. The posterior lip is grasped with toothed forceps and a generous wedge excised to avoid subsequent contraction at this dangerous area. The prostatic bed is finally carefully inspected for evidence of spurting vessels and if such are seen they are grasped with haemostats and lightly coagulated. A suitable sized (18-22 F) thin walled hollow tipped rubber catheter is next introduced on a curved stylet along the urethra and directed through the vesical neck into the bladder. The stylet is withdrawn. The capsular incision is now closed transversely with a continuous suture of No. 1 chromicized catgut using the boomerang needle (Fig. 263). It is all important to secure accurate apposition of the incised capsular edges to control bleeding and to minimize the possibility of urinary leakage when micturition is re-established. When the capsular suturing has been completed all bleeding

should have ceased. The retro pubic space is gently swabbed free of clots and carefully inspected to ensure that all oozing has been controlled. The space is dusted with 5 grains of sulphani lamide powder and a small corrugated drain left down to the suture line. The retractor is withdrawn and the rectus sheath closed with interrupted sutures of No. 1 chromic catgut. The skin is approximated with silkworm sutures and Michel clips.

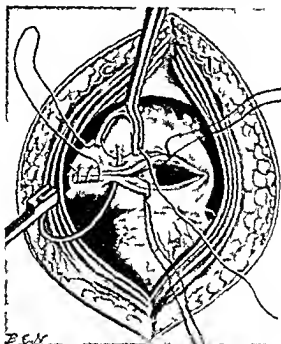


FIG. 963

St. + n. i. rostral capsule showing boomerang needle and iliac retractor

Bilateral vasectomy is performed and the catheter irrigated with 3.8 per cent sodium citrate solution to free it of clots. 4 oz. of lotion is left in the bladder and the catheter spigoted.

One hour after the patient's return to bed the spigot is released and the catheter allowed to drain continuously. Irrigation is employed only if there is evidence of faulty drainage and this is carried out with a meticulously aseptic technique. Should clots form and be not easily dislodged by simple irrigation an aspirating syringe is employed. (It is noteworthy that in more than 500 cases one suprapubic cystostomy has been carried out for reactionary or secondary hemorrhage, none for secondary bleeding.)

The catheter is usually removed on the third post operative day and the patient allowed out of bed unless contraindicated. In the vast majority of cases micturition is promptly re established but should there be evidence of difficulty or of urinary leakage a small rubber catheter is re-inserted for a further few days.

The most noteworthy features of the operation are —

- (a) Simple and relatively painless post operative course
- (b) Short confinement to bed—3 days

- (c) Short period of post operative catheter drainage—3 days
- (d) Early re establishment of micturition
- (e) Low incidence of post operative complications
- (f) Short hospitalisation (14-16 days)

In cases where a preliminary cystostomy has been necessary the retro pubic enucleation is feasible and little more difficult—it permits a closure of the cystostomy at the time of operation and micturition is re established on the 8th-10th post operative day without the risk of slow healing fistula.

The operation is analogous to the perineal method of ablation of the adenoma but carries no risk of damage to rectum or compressor urethra. It is simpler to learn and should carry a similar low mortality.

The retropubic approach is applicable also to various other types of prostatic obstruction. The fibrous type of gland is usually dealt with by endoscopic resection but where urethral stenosis or the necessity for open operation for other pathology is present wedge excision of the sclerotic vesical neck and scissor dissection of fibrous nodules from the lateral lobe areas can be readily carried out by the retropubic route.

The calculous prostate lends itself well to this approach. In general incisions of the prostate and evacuation of the calculi combined with a wedge excision of the sclerotic vesical neck so commonly associated suffices but in cases where the gland is grossly infected a subtotal prostatectomy may be indicated.

The carcinomatous prostate when the malignant process appears to be confined within the capsule can be most satisfactorily dealt with by the radical retropubic operation. The operation consists in a complete ablation of the gland within its capsule together with the seminal vesicles and half the bladder base. A plane of cleavage is readily found distal to the apex of the prostate anterior to Denonvilliers' fascia and thanks to the mobility of the membranous urethra this may be drawn into the pelvis some 2-4 cm. and sectioned distal to the affected gland. The prostate is then peeled off the underlying fascia of Denonvilliers and with appropriate dissection the mass removed *in toto*. The membranous urethra is finally approximated to the bladder in a manner somewhat similar to that adopted in the analogous radical perineal operation devised by Young the wide vesical outlet being appropriately closed.

TERENCE MILLIN

## CHAPTER XLII

### PERINEAL PROSTATECTOMY

**A**LL cases of simple hypertrophy, except where the prostate is very large, are suitable for enucleation through the perineum. In the latter type removal by this route is so apt to result in damage to the internal urinary sphincter, and in due course to incontinence of urine that the suprapubic route is the better one.

I prefer also not to deal with a fibrous prostate or prostatic calculi by the perineal route for the same reasons. In these cases it is the absence of a line of cleavage for the enucleation that creates a special difficulty. Young has a modified operation for carcinoma of the prostate. Where two stage prostatectomy is necessary there is the advantage that the patient is able to receive all the benefits of preliminary suprapubic drainage both before and during perineal prostatectomy, while the surgeon has no added difficulties in doing an open operation. My own modifications of technique are meant to apply particularly to two stage cases because the stitching of the bladder neck to the stump of the urethra interferes with dependent drainage.

Success in removing the prostate by the perineal route is largely a matter of observing certain principles in operative technique. Generally speaking, these may be stated as follows: a proper and fixed position of the patient on the operating table, provision of the special instruments required, a knowledge of the safeguards against operative complications.

According to the operative technique employed so the requirements in instruments will vary, but it is essential to have certain tractors and retractors, and if the bladder neck is to be stitched to the stump of the urethra a boomerang needle and a special urethral guide are invaluable aids.

Provision against certain important complications of this operation can be made: epididymitis is best avoided as in suprapubic prostatectomy by preliminary division of the vasa deferentia, injury to the rectum by care in dissection, and by the use of the rectal guide, incontinence of urine by avoiding injury to the compressor urethrae muscle, and to the internal urinary sphincter and by stitching the neck of the bladder to the stump of the urethra, primary hæmorrhage by the use of clamp and ligature as much as possible.

#### YOUNG'S TECHNIQUE

Young stresses the following points. For preference the anaesthesia is spinal, with 10 mg. of pantocain. The exaggerated lithotomy position of the patient is facilitated by the use of Halstead's perineal board or the special operating table devised by Young.

A No. 24 sound is passed until the beak is in the posterior urethra. The sound is held in this position by an assistant. The skin incision is V-shaped with the apex  $1\frac{1}{2}$  in. in front of the anus, so that each lateral limb passes backwards for about 2 in. within the ischiopubic ramus. The space behind

the transversus perinei muscle is identified by blunt dissection, thus exposing the central tendon. The finger is introduced upwards and forwards into the ischio-rectal fossa of each side passing behind the triangular ligament and away from the rectum. By means of a special bifid retractor the central tendon is displayed and then divided. By changing the bifid retractor for a simple one to draw the rectum back the recto urethralis muscle is displayed, as it passes backwards from the triangular ligament and bulbous urethra. This muscle is divided in front of the rectum.

By anterior traction with a special grooved retractor the triangular ligament and the external sphincter are drawn forward. Antero-posterior retraction now displays the apex of the prostate and the membranous urethra. An incision is next made into the membranous urethra behind the external sphincter. Others have modified this technique so that incision into the membranous urethra is avoided. The whole thickness of each lateral edge of the urethral incision is grasped with Allis's clamps.

The sound is now removed from the urethra and replaced by a straight one which is passed into the bladder through the urethral incision to prepare



FIG. 264  
Young's prostatic tractor

the way for the prostatic tractor, which is now introduced after which the blades are opened and traction to the prostate applied (Fig. 264). The prostate is seen to be covered by a thin fibromuscular layer. This should be incised at the apex of the prostate so as to expose the whitish layer beneath—the anterior layer of Denon-

villiers' fascia—which forms the principal part of the prostatic capsule.

The overlying tissue which passes on to the rectum is carefully incised, and the latter structure covered by the posterior layer of Denonvilliers' fascia is pushed back by blunt dissection and maintained in this position by traction.

Lateral retraction with Young's narrow bladed retractors now gives a good view of the under aspect of the prostate. A little further dissection will bring the seminal vesicles into view if necessary. Young has advocated three different incisions through the prostatic capsule as a preliminary to the enucleation—

- 1 An incision on each side of, and parallel to the prostatic urethra
- 2 Turning down a V shaped flap with the apex in the mid line and directed forwards
- 3 A single lateral incision

By the first method it was hoped to avoid damage to the urethra and verumontanum. This often proved impossible. The prostate by this method could not be removed in one piece. The second method enables the verumontanum to be preserved as it is on the V shaped flap which is turned down and gives a good view of the prostate which can now be removed in one piece.

By the third method also the prostate can be removed in one piece, and there is a prospect of preserving the ejaculatory ducts.

Of the three types of incision the V-shaped one is to be preferred. It is

advisable to remove the tractor in the presence of a middle lobe so as to facilitate the enucleation of the latter which may require the assistance of a curette. This manipulation can be done satisfactorily under vision by drawing upon the partly enucleated gland the mass usually coming away in one piece.

While the final stages of the removal are proceeding it is sometimes possible to preserve the cone of mucous membrane that proceeds from the bladder into the urethra. Bleeding points can often be seen and ligated at this stage. A modification in the enucleation is to break through the mucous membrane of the urethra on each side. This establishes a good line of cleavage and an expeditious removal.

A finger is next inserted into the bladder to see that no adenomatous or fibrous tissue projections are left behind. At the same time the finger moves more widely to see that there is no calculus in the bladder.

A large drainage tube is placed so as to project into the bladder and alongside of the drain a smaller one can be placed. Through this oil can be injected later on to facilitate the removal of the packing. This is placed round the large tube into the vesical orifice and into the lateral cavities. It is sometimes wise to place a pack behind the prostatic cavity. On the other hand the packing is sometimes replaced by sutures through the vesical neck and remaining prostatic tissue. The skin wound is closed so that the tube projects near the lower angle on the right side and the gauze ends projecting above this.

On return to the ward a subcutaneous saline infusion is given and the patient is started on to copious drinking as soon as possible.

In *duo curso* the patient is propped up in bed the packs are removed in twenty-four to forty-eight hours and generally the next day drainage by tube is also dispensed with. The patient is got out of bed on the third or fourth day and is encouraged to walk within a week—56 per cent of 450 of Young's cases had their fistulae closed in twenty-one days. Undue delay in closure calls for the passage of a sound per urethram. Early in the convalescence 20 c.c. of fluid are forced along the urethra and out through the perineum by means of a rubber bulb syringe. This should be repeated every four to five days until micturition is established. Undue delay with this calls for the passage of a sound. An indwelling catheter for at least a week is an alternative which is advocated and which is likely to obviate the use of sounds. Later in the convalescence this may be required to hasten healing in certain cases. Curettagage may be applied to the fistula for the same purpose. Among 3,500 cases operated on at the Brady Urological Institute the mortality was about 3 to 5 per cent.

There was no change in the capacity for sexual intercourse in 74 per cent. Young's perineal prostatectomy has been practised extensively by others often with modifications and all are agreed upon the low mortality and satisfactory convalescence which results.

**Winsbury-White's modifications.**—The writer has modified Young's technique in the following particulars by making a T shaped incision into the prostatic capsule (Figs 265 and 266) by using a special technique for stitching the posterior rim of the internal urinary meatus to the stump of the urethra (Figs 267, 268 and 269) in obliterating the bulk of the prostatic cavity by stitching together the two edges of the vertical limb of the T shaped incision as a hæmorrhagic measure (Fig 270). The V shaped incision of Young into the prostatic capsule allows the verumontanum and ejaculatory ducts to be turned down as a flap. This procedure is supposed to be a safeguard against epididymitis; this supposition however is fallacious.



The writer would call attention to further special points in his technique. First of all in approaching the gland a self retaining rectal guide (Fig 271, 2)

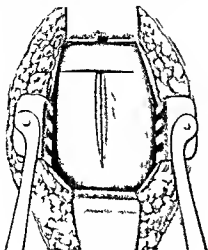


FIG 265  
The T shaped incision in the prostatic capsule

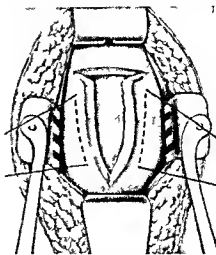


FIG 266  
The prostatic capsule has been separated from the gland for  $\frac{1}{2}$  inch on either side of the vertical incision and the traction sutures inserted

is secured in position so that it will not be necessary to place a finger in the rectum. The prostatic capsule is incised in such a way that a good thick

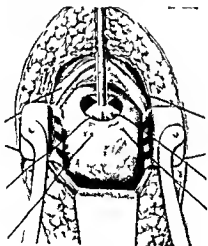


FIG 267  
The bladder neck tractor is pulling the internal urinary meatus well up towards the surface and suitable retraction is providing a good view of the undersurface of the bladder

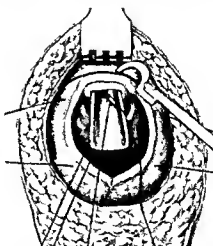


FIG 268  
With the urethral guide in position by means of the boomerang needle the sutures through the bladder neck are drawn through the stump of the urethra and the overlying tissues

portion may be separated under direct vision from the underlying gland. Because the undersurface of the neck of the bladder is thickened and strengthened by this capsule, if only a thin portion is left behind, two disadvantages result. The sutures which have to be passed subsequently through

this tissue may not be able to secure a firm hold and an extra amount of scar tissue will be formed in this situation. The writer's experience leads him to believe that these are both important factors in the production of incontinence of urine. As a final stage of the enucleation the gland should be separated from the urethra and the neck of the bladder by sharp dissection so as not to damage these structures. The neck of the bladder must be firmly secured by suture to the stump of the urethra and the overlying tissue (Figs 268-269). To accomplish this satisfactorily the parts must be adequately exposed. To

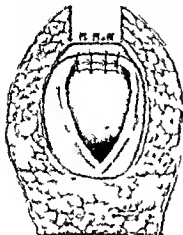


FIG. 269

The neck of the bladder is secured to the stump of the urethra the anterior margin of the incision in the prostatic capsule and the overlying perineal muscles.

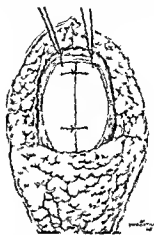


FIG. 270

The vertical incision in the prostatic capsule is closed and the capsule is secured anteriorly to the transverse perineal muscles.

provide extra support for the new posterior urethra and the readjusted bladder base the anterior margin of the re-sutured prostatic capsule is secured firmly to the perineal muscles lying superficial to the compressor urethrae (Fig. 270). Each of the steps in this form of reconstruction results in the obliteration of the prostatic cavity—except the anterior part—and plays a part in safe guarding against incontinence of urine.

The ease and thoroughness with which these important steps can be carried out depends in the first instance on the use of Young's boomerang needle and in the second on the employment of the special instruments which the writer has devised for the purpose of giving improved exposure and access as the operation proceeds (Fig. 271).

A word should be said concerning another post-operative complication namely recto-urethral fistula. This occurs as a result of injuring the rectum while it is being freed from the undersurface of the prostate. This is an accident which I suppose will happen at least once to every surgeon who gains much personal experience in perineal prostatectomy. In two of the writer's cases the patients were left with a leakage of urine from the anal orifice, and it was necessary to operate again later to separate the rectum from the prostatic capsule where the fistula existed. The results were completely satisfactory. In two others the perineal operation was stopped as soon as the rectum was injured and the prostate removed by the suprapubic route. No recto-urethral

fistula resulted and the convalescence in each case was neither prolonged nor did it give rise to any anxiety. It is always before the urethra is opened that

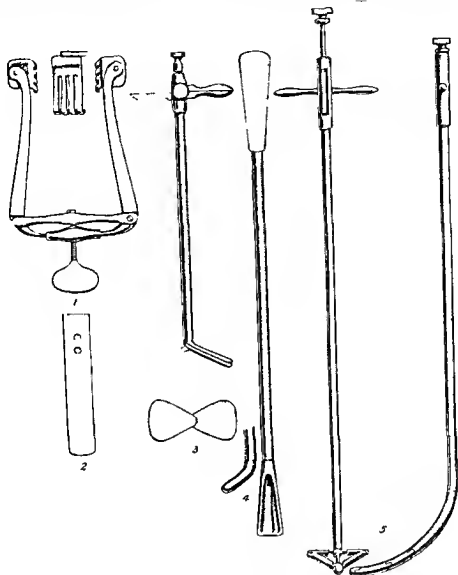


FIG 271

The author's perineal prostatectomy instruments. 1 The self retaining perineal retractor 2 The self retaining rectal guide 3 The bladder neck tractor with the blades open and closed 4 The urethral guide with its detachable beak and grooved attachment 5 The prostatic tractor in the open and closed positions

the rectal injury occurs. Thus the danger of fistula is entirely eliminated by not proceeding to open the latter structure.

H. P. WINSBURY-WHITE

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## CHAPTER XLIII

### TRANSURETHRAL RESECTION OF THE PROSTATE BY THE MCCARTHY METHOD

#### HISTORICAL NOTE

THE transurethral approach to the obstructing prostate is the logical outcome of the primitive methods of treatment employed long ago by Mercier Civeale and Bottin (1874). What they attempted to do by blind and crude methods the modern operator carries out under full ocular control and with an increasing degree of precision. Two advances along other lines of scientific progress have been responsible for the great progress which has been made in transurethral surgery: first the perfecting of the irrigating cystoscope and second the introduction by Beer of high frequency currents into the realm of surgery. So many different urologists have shared in perfecting the methods at present in use that it is impossible to give credit to all the pioneers who have been responsible for this valuable method of treating prostatic and bladder neck obstructions. Special mention must however be made of H. H. Young (1909) who by his introduction of the prostatic punch redirected the attention of urologists to the transurethral approach, of J. R. Caulk (1920) for his work with the electrocautery punch and of G. Luys (1919) for his application of diathermy to the obstructing prostate. Their work together with that of many others has resulted in the creation of the McCarthy resectotome, the instrument most commonly used in this country in transurethral prostatic surgery.

#### THE MCCARTHY ELECTROTOME

This instrument is so well known that a detailed description of it is unnecessary. It consists of an outer sheath, an articulated obturator, a loop carrier fitted with a foroblique telescope and an irrigating system. The sheath is made of bakelite and its distal end is cut away in order that the wire resecting loop may be free to engage and resect obstructing tissue. The loop itself is made of tungsten wire and can be moved backwards and forwards by means of the rack and pinion of the carrier into which it is fitted. In order that bleeding points may be sealed off, a ball electrode can be substituted for the loop and activated by a coagulating current.

A great many modifications of the McCarthy instrument have been introduced by different instrument makers to meet the requirements of individual genito-urinary surgeons. The instrument which I personally favour is made by the Genito Urinary Manufacturing Company and is of the pattern advocated by Ogier Ward (1939) see Fig. 272. In this instrument an inclined plane has been built into the back of the sheath which has the effect of pushing the cutting loop forward as it is advanced into the cutting position. This has two advantages—first that it provides a wider range of movement and second that it ensures that the loop remains in the optical field when in the forward position. Working with this instrument it is possible to make deeper excavations in the prostate than can be made with the original

McCarthy instrument an advantage that is of great importance in the sub-vesical technique of resection later to be described. The disadvantages that result from this modification are that because the angled obturator cannot be used the instrument is a little more difficult to introduce, and the fact that a catheter cannot be threaded through the sheath at the conclusion of the operation. Another modification in this instrument is the substitution of an irrigating system controlled by a single lever for the usual inlet and outlet tubes. Thus as well as allowing of better control, ensures the passage of a good volume of irrigating fluid throughout the whole of the operation.

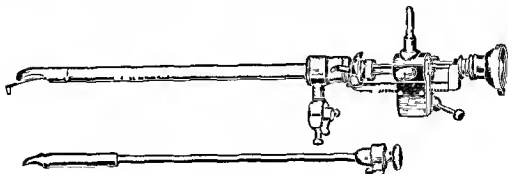


FIG 272

McCarthy electrotome with Ogier Ward's modification

**Operative technique**—With the patient in the usual lithotomy position the urethra is explored with a full sized metal bougie and if necessary, dilated. After the sheath has been introduced and the telescope loop and irrigating system substituted for the straight obturator, a careful survey is made of the field of operation. The configuration of the bladder neck is noted, a rough estimate made of the amount of tissue which it will be necessary to remove in order to restore free micturition and a plan of campaign drawn up. The verumontanum is located. This is a very important landmark which establishes the proximal limit of the area to be resected, and it should be preserved from injury during the whole of the operation. The resection is usually begun in the mid posterior line, the loop being advanced into the bladder. After the mid line cuts have been completed, attention is turned to the lateral lobes. But before dealing with this part of the operation it will be helpful to consider the general plan of the resection. When the usual technique is employed not only is that portion of the prostate which surrounds the prostatic urethra removed but also a large area of the trigone. That this is so can be demonstrated by introducing a finger into the bladder at the end of the operation, in those cases in which there exists a suprapubic opening. It will then be found that the operation of resection has removed a cone of tissue, the apex of which lies at the verumontanum and its base on the trigone. The operation has thus removed a considerable part of the base of the bladder. This has the grave disadvantage of increasing the bleeding during the operation and also of augmenting the subsequent sepsis. Ogier Ward has pointed out that the anatomical condition of the bladder neck left by this method of resecting is quite different from that found after prostatic enucleation. In the latter case an internal meatus still exists, and beneath it lies a large cavity left by the removal of the prostate. He is of the opinion that the operator should endeavour to obtain by means of resection an anatomical result similar to that existing after a prostatectomy. In order to do this the loop must not encroach on to

the trigone except during the preliminary cuts in the mid posterior line. It should rather be dug into the substance of the prostate at a level immediately below the internal meatus. By this method the trigone is safeguarded and the prostate excavated from below. At the moment when the current is turned on, the beak of the sheath is pressed firmly in the required direction and the cut made thence downwards in the direction of the verumontanum. These cuts may have to be extended towards the anterior aspect of the prostate but it must be remembered that only a small thickness of gland exists in this situation. This is one of the danger points where too deep a cut will lead to extravasation of urine between the transversalis fascia and the peritoneum.

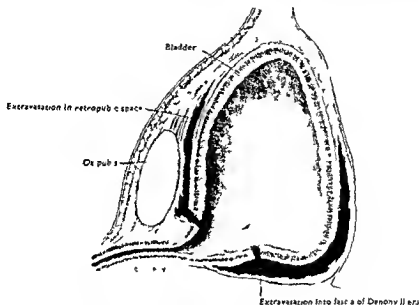


FIG. 273

Infection and extravasation of urine anteriorly into the retropubic space and posteriorly into the fascia of Denonvilliers

In my own practice this has occurred three times twice with fatal results. Eventually a stage is reached when further cutting into the lateral lobes becomes a mechanical impossibility and the resection may then be regarded as being complete.

The main difficulty encountered during the resection comes from hemorrhage and the obscuring of the field of vision by blood. Since a cut in a wrong area may have serious consequences it is important that the operator should know exactly what he is doing. Some resectionists deal with each new bleeding point in turn as it appears by sealing it off with the coagulating current. But this entails a constant interruption of the resection in order that the ball electrode may be substituted for the loop. For this reason I prefer to carry on as long as I am able to do so, and then to attend to the hemorrhage. This is likely to be less copious if each lateral lobe is attended to in turn and both not resected at the same time. Another interruption is caused by fragments of tissue falling into the bladder instead of adhering to the loop. These are best removed at the end of the operation by attaching a Bigelow's evacuator to the sheath by means of a special connecting piece. A retrograde telescope

is a useful addition to the resectionist's outfit since it allows of his viewing his work from the inside of the bladder. Sometimes this allows him to see portions of prostate which if left may still be the cause of some obstruction.

When the operator is satisfied that hæmorrhage has been controlled and that all fragments of prostate have been evacuated a catheter is introduced. Personally I prefer one of the Foley type (Fig 274) which obviates the



FIG 274  
Foley Catheter

necessity of covering the penis with strips of elastoplast in order that it may be retained. If there is difficulty in introducing it I use the largest size of gum elastic catheter that the urethra can comfortably hold. A wooden spigot may be temporarily placed in the end of the catheter until the patient is back in bed and it can be connected up with a St Mark's Hospital irrigating apparatus.

Should the operator be dissatisfied with the hæmostasis he has secured he need not hesitate to drain the bladder by means of a suprapubic tube. Nothing is likely to be more distressing to a nervous patient than to be told after he has recovered from the anæsthetic that the catheter has become blocked with blood clots that the bladder is distended and that for this reason he must be returned to the theatre for the insertion of a tube. Although recourse to suprapubic drainage is a confession of failure to secure hæmostasis by the methods appropriate to resection it only adds a few days to the total period of convalescence. Provided the obstruction has been removed the fistula will close within a few days of the taking out of the tube. Moreover temporary suprapubic drainage makes for an easier convalescence and allows of better irrigation of the bladder. I am therefore disposed to introduce a tube whenever the patient is of a nervous type who is likely to be intolerant of an indwelling catheter or when the resection is likely to be followed by much sepsis. Formerly I performed a bilateral vasotomy in order to guard against a descending infection of the epididymes. I no longer think that this is necessary.

**Anæsthesia**—Perurethral operations can be carried out under general anæsthesia or under a low spinal, a transsacral or a caudal anæsthetic supplemented by surface anæsthetization of the urethra. Of these methods a low spinal and general anæsthesia have the widest application. When the patient is nervous and objects to being conscious in the operating theatre a general anæsthetic is preferable. It has the disadvantage that it raises the blood pressure and thereby encourages bleeding during the operation.

**Pre-operative treatment**—This is the same as for a suprapubic prostatectomy. If a large amount of residual urine be present preliminary drainage by means of an indwelling catheter will be required until the kidneys have fully recovered their function. The fact that a transurethral resection is a less severe operation than a prostatectomy does not exonerate the surgeon from carrying out careful pre-operative renal function tests. Should these prove so unsatisfactory that a long period of preliminary drainage is necessary,

or should the bladder be badly infected a preliminary suprapubic drainage will be necessary

**After-treatment**—As in the case of prostatectomy the commonest complications after a resection are hæmorrhage sepsis and uræmia. Post operative hæmorrhage is dealt with by keeping the patient as quiet as possible if necessary with the help of morphia and by ensuring that the indwelling catheter does not become blocked by blood clot. For the first few hours after the operation the catheter requires constant attention and the bladder must be washed out whenever it appears to be becoming blocked. If the lumen cannot be freed by the irrigating apparatus the clots may be got rid of by the use of a syringe. Should this fail the catheter must be removed and a new one substituted. Prior to the employment of a Bigelow's evacuator for getting rid of cylinders of prostatic tissue which had fallen into the bladder I frequently found that the eye of the catheter had become blocked not by clot but by fragments of prostate. This accident now happens very rarely.

Secondary hæmorrhage may occur a week after the resection but I have known it to be delayed as late as the fourth week of convalescence. When it occurs it is not likely to be serious and provided the bladder can be kept from becoming distended it subsides spontaneously.

Post operative sepsis is dealt with by frequent washing out of the bladder and by the use of urinary antiseptics either of the mandelate or of the sulphoramide group. By avoiding as much as possible the region of the trigone and by using the subcervical method of resection I have reduced this considerably in my own practice. Previously I encountered severe and persistent infections which were almost certainly due to implication of the cellular tissues lying on the postero-inferior aspects of the bladder.

Authorities differ as to the time during which a urethral catheter should be retained. My own opinion is that this must depend on the amount of tissue which has been removed and on the severity of the post operative sepsis. Unless the patient very much resents the presence of a catheter I prefer to continue urethral drainage for four or five days. After it has been discontinued a catheter should be passed daily in order that the residual urine may be estimated and the bladder washed out. Because resection is likely to be followed by some swelling of the tissues in the neighbourhood of the bladder neck the residual urine is often disappointingly high for some time after the operation. This need not be taken as a sign that the resection has been a failure for I have known a patient to be incapable of passing urine for two weeks after a massive resection and then to make an excellent recovery. Should however the result of the operation be found to be unsatisfactory cystoscopy with probably a further removal of tissue will be necessary. When the surgeon has to deal with a very large prostate or when hæmorrhage during the operation has proved to be very troublesome it is often preferable to complete the resection in two sessions. After the patient has left the hospital or the nursing home he should still be seen occasionally in case there has been any recurrence of infection.

The treatment of uræmia is similar to that employed for uræmia following an enucleation.

**Mortality**—When resection was first introduced there were enthusiasts who claimed that it was devoid of risks. This is a gross error for any surgical procedure must entail some risk to an elderly patient whose health has previously suffered as the result of long standing obstruction associated in many cases with infection. It is difficult to state in figures what risk is attached to the operation of resection for the mortality rate of any individual surgeon



will depend to a large extent on his willingness or unwillingness to operate on unpromising material. It will also depend on the number of resections he has carried out for there is no operation in the whole realm of surgery in which experience counts for so much as in the operation of resection. Every resectionist who looks back at his past records will see that there has been a gradual drop in his mortality rates. Resection far from being a simple procedure is an operation which demands a high level of skill and discrimination. A cut in a wrong position may have serious consequences as was only too apparent when resection was carried out by operators who previously had had but little experience of cystoscopic methods. This led to a harvest of cases of extravasation of urine of serious hæmorrhage of intractable sepsis and even of recto vesical fistule. Were the percentages published by experience 1 proctotomists to be collated it would be found that their mortality rate was somewhere between 2 and 4 per cent.

### SELECTION OF CASES

The key to success in transurethral resection lies in the careful selection of the cases which are submitted to it. There are those who believe that every case of prostatic obstruction can be dealt with satisfactorily by means of resection but most surgeons agree that the transurethral approach is not a general substitute for prostatectomy but a method which is applicable to special cases and to special circumstances. In general terms it may be stated that it is applicable to all those cases in which the amount of enlargement is small although the degree of obstruction may be considerable. The operation is therefore suited to cases of fibrous prostate of middle lobe enlargement to lesser degrees of lateral lobe enlargement and to cases of carcinoma. It is particularly suited to all those conditions known to French urologists as *prostatisme sans prostate* and to American urologists as *prostatic bar*. It is also the operation of choice for the relief of obstruction caused by carcinoma of the prostate. Formerly the only available method of dealing with such cases when a rising residual urine demanded that something should be done was the establishment of a permanent suprapubic drainage. Transurethral resection has provided a welcome alternative to what some patients find to be an intolerable condition. An additional advantage is that resection allows of tissue being sent to the pathologist for a report whenever doubt exists as to the true nature of the prostatic enlargement. The objection that the use of diathermy may stimulate the rate of growth of the carcinoma is purely theoretical and I have no evidence in my own practice of this having happened.

The special circumstances in which resection may be resorted to are where for one reason or another a prostatectomy is contraindicated either because the general condition of the patient is too poor or else because he is suffering from a serious complication. In these circumstances resection even although it must carry with it a small risk offers an excellent alternative to catheter life or to the establishment of a permanent suprapubic drain. The possibility that the subsequent growth of the prostate may lead to a recurrence of obstruction and the necessity of another resection is not so serious a drawback as might be supposed. The discomforts attached to a skilfully performed transurethral resection are so much less than those associated with a prostatectomy that a patient will usually submit with good grace to a second operation should this eventually become necessary.

**Complications**—A certain amount of hæmorrhage and of sepsis are invariable

after a perurethral resection and only if they become excessive need they be regarded as being complications. Provided that the sealing off of bleeding points has been efficiently carried out reactionary hæmorrhage need not be feared. Should it occur and all effort to free the indwelling catheter from clots prove fruitless no hesitation need be felt in opening the bladder and inserting a temporary suprapubic tube. The bleeding will stop when the bladder has been emptied of clot and retained urine and if the drainage tube be removed at the end of a few days the total length of the patient's period of convalescence will have been only slightly increased by his second operation. As after prostatectomy secondary hæmorrhage may occur at the end of the first week I have never known it to be so serious as to require special measures for combating it.

Sepsis is only likely to be severe if considerable trauma has been inflicted on the tissues or if the loop has opened up fascial planes. The passage of too large an instrument along the urethra increases the probability of sepsis. So also does excessive coagulation of the prostatic tissues. Some urologists consider the amount of coagulation caused by the McCarthy electrotome to be such a serious objection that they have preferred other techniques such as the Thompson technique used at the Mayo Clinic. In this the cutting out of tissue is done by a cold knife and coagulation is confined to touching up bleeding points afterwards.

Stricture may follow trauma inflicted on the urethra during the passage of the instrument. In elderly patients whose genitalia have involuted a forcible introduction of the electrotome must not be attempted.

Epididymitis is not a frequent or serious complication. Undoubtedly the sequel which is most to be feared is extravasation. This has already been discussed.

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## CHAPTER XLIV

### TRANSURETHRAL RESECTION OF THE PROSTATE BY THE METHODS IN USE AT THE MAYO CLINIC

**B**EFORE describing punch prostatectomy in detail, certain general principles may profitably be discussed. It is one of the variations of transurethral prostatectomy. There is nothing essentially new in this approach to the prostate and the names of Mercier, Bottini, Freudenberg, Young and, in particular, Caulk immediately suggest themselves. Adoption of such an approach was until recent times, severely handicapped by imperfections in the instruments available, but modern improvements in cysto-urethrosopes and electro-surgical apparatus have changed a speculative and hazardous method into one of precision and comparative safety. Even at the present time however, such methods demand careful apprenticeship and painstaking attention to detail on the part of the surgeon undertaking them. They should not be attempted by the occasional surgeon, whose efforts are only too likely to result in misfortune to the patient and discomfiture to the operator, at the same time bringing a valuable method of treatment into unjustifiable disrepute. Trained teamwork and vigilance in the post-operative treatment are demanded, without which no amount of individual skill on the part of the operator will be of any avail. Nevertheless there is no essential mystery in the procedure, which rests on sound surgical principles and which can be practised by all prepared to study the technique thoroughly.

The employment of a knife or punch to cut the tissues is based on the view that it is better to cut the tissues with a knife than with an electrical cutting current. A sharp knife produces the minimum destruction and devitalization in tissue left behind after section, whereas electrical currents by their heating effect are prone to produce these undesirable changes. We should expect, therefore, that the incidence of post operative sepsis following punch resections would be less than after those performed with an electrotome, and this claim can fairly be made. Kenneth Walker (1937) supports this view.

One of the complications after prostatectomy by any method is urinary incontinence and, in the minds of many, transurethral prostatectomy is particularly associated with this disaster, which is due to incompetence of or damage to the voluntary sphincter. There is a fundamental difference in transurethral resection when carried out with a punch from the operation carried out with an electrotome. In the first case the surgeon visualizes the verumontanum, and always cuts upwards from it towards the bladder, making the risk of damage to the external sphincter minimal. In the latter case the operator cuts from the bladder neck downwards towards the exterior, and has no very definite control of the distance of the section, which, if prolonged, is bound to damage the sphincter. If incontinence occurs after punching, it is usually due to dilatation of the urethra and disappears quickly.

Another great difference between the two types of transurethral prostatectomy derives from the fact that the instruments were developed along quite different lines. The punch was developed from the direct vision, lens

less cystoscope giving no magnification and in the use of which vision is not seriously impeded by hæmorrhage. It follows as a corollary that no surgeon can hope to master the punch until he is accustomed to the use of the Braasch direct vision cystoscope. It is also obvious that as this method has been developed and perfected at the Mayo Clinic it is desirable for the intending resectionist to visit the Clinic to obtain instruction. Resection was introduced there by Bumpus using the Braasch Bumpus punch which is simple to understand and very suitable for resections requiring the removal of a small amount of tissue. Resection has been further developed on a large scale by the brilliant work of Gershom Thompson and his assistants using his improved punch which enables more rapid resections to be carried out. The writer is deeply indebted to Gershom Thompson for his great help and courtesy in demonstrating his methods.

In punch prostatectomy hæmorrhage is controlled by fulguration of spurting points with a diathermy electrode transmitting a coagulating current which is used at intervals during section of the prostate with the knife. No attempt is made to stop all bleeding as this is unnecessary and heavy coagulation can only result in undue necrosis of tissue.

There is more primary hæmorrhage during a punch resection than during one performed with an electrotome and the bleeding should never be allowed to get out of control. The incidence of secondary hæmorrhage on the other hand is negligible—a more important point.

There has been much discussion as to the aim in transurethral resection. Can the whole prostate be removed or not? It may be stated at once that the whole prostate can be removed in the same sense as it is removed by suprapubic prostatectomy. It may not often be necessary to do so but it can be done. It is wrong to visualize the operation as channelling of the prostate. The aim is to produce a wide open funnel at the bladder neck by the removal of the necessary tissue. Some may be rather contemptuous of the resectionist industriously removing the prostate in small fragments when a rapid sweep of the finger may produce an impressive mass in a much shorter space of time. A consideration of mortality figures supplies the answer. Further in considering mortality figures it must be remembered that transurethral prostatectomy can be performed on patients whose condition entirely precludes other forms of prostatectomy.

### INDICATIONS

Transurethral prostatectomy can be used to treat various pathological states of the gland and has established itself firmly as a means of treatment particularly in cases where other operations are prone to be unsatisfactory.

1 **Benign enlargement**—The anatomical site of the enlargement will vary, possibly an enlargement of the middle lobe alone may be present or more diffuse lateral lobe or trilobar enlargement. It is easy to remove a solitary middle lobe but it is well to bear in mind that in the majority of cases there is lateral lobe enlargement also and unless this is dealt with only incomplete relief will be afforded. The benign prostate is soft and composed of numerous adenomatous masses. As a result removal of only a portion of the lateral lobe causes the rest to collapse into the urethra and to produce more obstruction than ever. Therefore resection in lateral lobe enlargement must be thorough. Hæmorrhage is as a rule free especially when concomitant

prostatitis is present Opponents of the method suggest that there is a risk of carrying out an inadequate removal in early cases of carcinoma presumed to be benign This appears rather a theoretical argument

2 **Carcinoma**—In cases where obstruction is present or threatened, the punch offers an alternative to suprapubic cystostomy The argument that it is unsound to cut away part of a malignant tumour, with the possible risk of encouraging dissemination, is not borne out in practice Hæmorrhage is slight and as the gland is tough there is no tendency for the sides of the urethra to cave in causing further obstruction

3 **Fibrous prostatitis with bar formation**—Enucleation of such prostates is impossible and the punch is an excellent instrument for the precise removal of such obstructions at the bladder neck As the condition is due to subacute inflammation this must be treated on the usual lines, otherwise recurrent obstruction may develop

4 **Post-prostatectomy obstructions at the bladder neck**—These may result whatever variation of prostatectomy has been performed previously, and can be dealt with efficiently by the punch Such scars may be found to be highly vascular

### THE THOMPSON PUNCH

This was developed from the Bumpus punch by Gershom Thompson, and first reported by him in 1935 (Fig 275) It is essentially an endoscope,

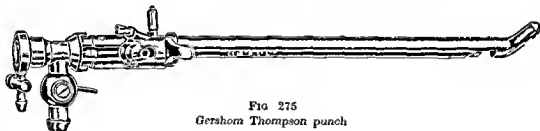


FIG 275  
Gershom Thompson punch

carrying a light in the beak which illuminates the bladder and urethra and makes it possible to visualize these structures directly through the straight part of the instrument The bladder is distended with fluid to render visualization possible, and the fluid is prevented from escaping by a circular window at the outer end There is no lens system incorporated and therefore no magnification of objects viewed The sheath has a fenestrum cut in it near the bladder end and on the opposite surface to the beak Inside the sheath a tubular knife can be moved backwards and forwards, the effect being that the fenestrum is closed when the knife is in the forward position and open when it is pulled back Any projecting tissue at the bladder neck or in the prostatic urethra will prolapse into and be gripped by the fenestrum On pushing the knife forward the tissue engaged will be cut off and washed into the bladder by the pressure of the irrigating fluid This fluid is controlled by an inlet tap at the outer end of the tubular knife Under the outer end of the sheath is situated an outlet tap of larger bore than the inlet and, if this is opened while the inlet tap is closed, the contents of the bladder together with any resected tissue will be expelled In the beak surface of the sheath, which is ovoid on cross-section, there is contained a fine channel through which an electrode can be passed and projected into the field of vision when it is required to coagulate a bleeding

point. The circular inspection window has a fine tap immediately below it which when open allows a continuous flow of fluid behind the window thus checking any tendency for the view to become obscured. The instrument is made in two sizes—27 and 30 French.

**Operation technique**—Spinal anaesthesia is the most suitable although in some cases pentothal can be used. The patient is transferred to a cystoscopic operating table which permits of the thighs being abducted and flexed to 45 degrees. The buttocks reach the end of the table incorporated in which is a tray to catch the irrigating fluid and convey it to the drain. A large amount of sterile water at body temperature will be required and this can be stored in an irrigator tower or better in a constantly heated tank in an annexe to the theatre whence it is conveyed by piping to the operating table. It is important not to allow an undue head of pressure otherwise dangerous over-distension of the bladder may occur. It is a convenience if the various electrical leads required hang down from the roof of the theatre above the table. Means of darkening the theatre are also desirable.

The genitalia are washed down thoroughly with soap and water and finally with antiseptic lotion. Sterile drapes are then applied covering the lower half of the patient the penis being drawn through a small hole in the centre. The urethra is then dilated to 30 F. It is important not to traumatize it in so doing and if necessary a meatotomy must be performed. If the bulbous urethra is small no attempt must be made to overstretch it but a perineal section made and the punch introduced into the bladder by this route. In moderate degrees of urethral stenosis the 27 F. instrument can be used. The Thompson resectoscope having been introduced into the bladder the obturator is removed. The irrigator pipe is attached to the inlet connection the light and diathermy leads connected up and a preliminary inspection of the bladder neck made. The points to be noted are the length of the urethra as measured from the verumontanum to the bladder neck and the type of obstruction present whether due to a bar, a purely middle lobe enlargement or lateral lobe enlargement. When an inverted V on the anterior lip of the internal meatus is observed denoting lateral lobe enlargement it is often helpful to introduce a retrograde lens cystoscope to assess the extent of the intravesical projection. If trilobar enlargement is present the lateral lobes should be resected first starting above with the part projecting into the bladder. The first cuts should be made at one and eleven o'clock as this causes the lobes to drop downwards making subsequent section of the posterior and inferior parts easier. During section the inlet tap is open the pieces cut off being washed up into the bladder. When the bladder is full the inlet tap is closed and the outlet opened allowing the bladder contents including any resected pieces to flow away. It is helpful to have a small wire basket resting on the tray under the outlet tap to collect any resected pieces from the outflowing fluid. Haemorrhage should never be allowed to get out of control and bleeding points should be coagulated with the electrode before proceeding to further resection. As removal of the lateral lobes progresses the cuts are made in the lower part of the lobe bulging into the urethra but care is exercised always to visualize the verumontanum and never to cut below it. During the latter stages of lateral lobe resection it may be helpful to have an assistant introduce his finger into the rectum and push the remnants of the lobe inwards towards the fenestrum of the instrument. When the lateral lobes have been removed adequately the middle lobe is dealt with on similar lines care being taken to identify the trigone and interureteric bar above as it is possible to damage this. The resection is continued until the pearly transverse fibres of

the prostatic capsule are clearly seen. It is essential that the knife should be very sharp otherwise ribbons of prostate may remain attached at the upper end if the vesical mucosa has not been divided completely. This leads to excessive hæmorrhage and difficulty in extracting the pieces. Any portion which hangs up in the base of the bladder can be picked out with crocodile forceps introduced down the lumen of the punch. At the conclusion of the operation or at any time that the operative field becomes obscured by clots the bladder can be cleared by suction with an evacuating syringe temporarily attached to the end of the punch for the purpose. No attempt is made to render the bladder efflux absolutely colourless at the end as this would entail excessive coagulation. A pinkish colour is satisfactory and need not give rise to any anxiety. A 22 F whistle tip rubber catheter is taped into the urethra or alternatively a Foley self retaining catheter inserted. No operation should last over one hour and preferably not more than forty five minutes. If necessary a further resection can be performed later.

**After-treatment**—Scrupulous aseptic treatment is essential. The indwelling catheter is connected by rubber tubing to a glass container attached to the side rail of the bed. The whole of this is sterilized and all replacements are made with sterile tubing and bottles the attendant scrubbing up to effect any adjustments. It is essential that the catheter should be kept clear of clots and it should be irrigated with warm boracic lotion at half hourly intervals until all active bleeding has ceased. Clot retention in the bladder is a most serious complication and if not dealt with promptly may lead to the death of the patient. Prevention is better than cure and regular irrigation is the safe guard. If in spite of this the catheter becomes blocked it must be changed promptly first introducing an evacuator to remove all old clot from the bladder and enable it to contract. This is usually adequate as active bleeding has ceased. The patient is allowed up after forty eight hours and the catheter is removed on the fourth day. Eight hours later the residual urine is estimated and if this is appreciable or there is any difficulty in voiding a catheter is reintroduced for a few days. If after this the patient still cannot void completely further resection of tissue must be carried out. This is usually easier than on the first occasion and as only slight coagulation of tissue has been produced there is no difficulty in recognizing important landmarks. A urinary antiseptic preferably sulphonamide is administered in the post operative period.

#### PROGRESS AND STATISTICS OF TRANSURETHRAL RESECTION AT THE MAYO CLINIC

This work may be said to have commenced when Braasch introduced his median bar excisor in 1918. This was a modified direct vision cystoscope but severely handicapped by the lack of any means of controlling bleeding. There was no further progress until Bumpus (1926) having had some unsatisfactory results with Caulk's instrument devised his punch from a Braasch cystoscope. The reader is advised to study a paper by him (1932) which gives a full account of his instrument technique and results in 250 cases operated on by him in the years 1925-31 with a mortality of 2.4 per cent. At the Mayo Clinic in 1931 41 per cent of patients with prostatic hypertrophy were operated upon by the transurethral route. Thompson (1933) recorded 205 patients treated in the first nine months of 1932 representing 85 per cent of the prostatics subjected to surgery. 17.5 per cent of these were deemed to need preliminary suprapubic cystostomy for sepsis or poor renal function. He used

the Bumpus instrument there was no death in the series and 90 per cent were dealt with by one resection. Thompson (1933) reported that the percentage of prostates treated by the transurethral route had risen to 98 per cent. Thompson (1934) discussed the prevention of complications. Following Cabot and Meland (1932) he opposed any preliminary catheter drainage when renal function is adequate as the risk of infection is introduced and in cases already infected there is a risk of cross infection. In a group of 721 patients in 1932 and 1933 57.3 per cent were operated on without preliminary preparation other than routine investigation. 12.2 per cent with advanced renal damage were subjected to suprapubic cystostomy and the remaining 34.5 per cent were drained by catheter for from three to seven days. In a group of 200 cases drained by catheter with strict aseptic precautions 94 became infected with organisms. He expressed the view that it is possible to decompress the chronically distended bladder safely in hours rather than days. Cystoscopy should be postponed until the actual time of resection and should include the use of the retrograde lens. Preliminary investigation involved renal efficiency tests and X-ray investigation often including intravenous pyelography. The vas deferentia were tied in all men over 70. Operation should never be prolonged over ninety minutes but if necessary a further resection carried out later. This was found necessary in 13.6 per cent. Excessive coagulation and heating of the bladder irrigating medium were carefully avoided. The urethral catheter was removed in from forty eight to seventy two hours. Six hours after its removal residual urine was estimated. If below 6 oz. the patient was left for twenty four hours and then catheterized again. If over 6 oz. a catheter was passed six hours later and if residual urine was again found a catheter was tied in for from two to three days. If on removal of the original catheter there was complete inability to void the catheter was reinserted. If two to three days later voiding was still impossible further resection was carried out. If there was no residual urine after the original resection forced fluids and antiseptics were given. If a small amount of residual urine was found daily bladder washes were given until it disappeared. Clot retention developing after resection was dealt with by passing an evacuator and sucking out the clots. In the 721 patients there was a mortality of 0.7 per cent and in a further 451 cases no mortality.

Thompson (1933a) discussing the same series of 721 patients gave further details. Procaine spinal anaesthesia was given using 50 to 100 mg. of the drug. The pathological condition of the prostate was: contracture of the vesical neck 9 per cent, middle lobe hypertrophy 25 per cent, lateral lobe enlargement 23 per cent, trilobar enlargement 30 per cent and carcinoma 13 per cent. The amount of tissue resected was under 5 gm. in 26 per cent, 5 to 10 gm. in 28.7 per cent, 10 to 25 gm. in 35.5 per cent and more than 25 gm. in 9.8 per cent. In one case 116 gm. were resected. The stay in hospital was under fourteen days in 81 per cent.

Thompson recorded a recurrence rate of 2.7 per cent over a ten year period which compares favourably with the results of other operations for prostatic hypertrophy. Discussing this point again (1935) he stated that 1,694 resections were performed at the Mayo Clinic between 1st January 1913 and 1st January 1935. Forty nine patients returned with evidence of recurrent obstruction. In 16 the condition was malignant and in 33 benign. Of the latter 10 were due to chronic prostatitis with bar formation—a type prone to recontracture. The remaining 23 had definite hypertrophy at the original operation and subsequently developed regrowth of prostatic tissue although 6 said they had never been relieved completely by the operation. Primary



operation should be thorough and if a good functional result be not obtained immediately further resection should be carried out at once

Thompson and Emmett (1935) discussed resection for carcinoma at the Mayo Clinic. In a series of 107 cases the mortality was under 1 per cent. They suggested that radiotherapy should be combined with resection which they regard as superior to any other form of treatment.

Thompson and Buchtel (1936) discussed resection for the large prostate taking a group of 200 cases in which more than 25 gm were removed. In this article Thompson described his improved punch which enables more rapid manipulation and is therefore indicated particularly where extensive resection is necessary. He stressed the importance of correcting an inverted V deformity anteriorly and commencing the resection well forward on the lateral lobes. Major hæmorrhage should be controlled at once. In 43.5 per cent operation was performed in several stages. Five cases had to be returned to the theatre for diathermy to a post operative bleeding point. Seventy per cent had acute retention on admission. 44 per cent were over 70 and the mortality was 1.5 per cent.

Thompson (1937) discussed occasional unusual enlargement of the lateral lobes with intravesical projection and emphasized the necessity for the use of the retrograde cystoscope in preliminary investigation.

Thompson (1939) discussed resection at the Clinic in 1937-38—1 697 patients were operated upon. 86 required two resections and 4 three resections. Preliminary cystostomy was only necessary in 5 cases and he expressed the view that cases of severe renal damage do better with an indwelling catheter and resection. The mortality was 1.6 per cent.

Thompson (1940) gave details of resections carried out at the Clinic in 1939. One thousand cases were operated upon necessitating 1 040 resections. Forty five patients were over 80 years of age and 3 over 90. Eighty seven per cent were suffering from benign enlargement. Twenty eight per cent had a blood pressure of over 160 mm. The average amount resected was 34 gm. The largest amount in one resection was 139 gm and in two resections 184 gm. Sixty five per cent were retained in hospital for less than seven days. The mortality rate was 0.9 per cent.

#### MAYO CLINIC METHODS IN THIS COUNTRY

Wardill (1941) using the technique at Newcastle has described 230 cases with most encouraging results. In a recent personal communication he reports a larger series of average age of 75 years with a mortality of 7 per cent. Many of these were derelicts quite unsuitable for any other form of prostatectomy who would otherwise have been condemned to permanent suprapubic cystostomy. In the author's opinion many of these patients were far worse risks than the average run of patients encountered at the Mayo Clinic.

The author (Robinson 1936) described 50 cases using the Bumpus instrument and has since used the Thompson instrument or a modification of it (1939) in some 300 cases.

Stewart of Bradford (1945) recorded 621 cases with a mortality of 3.7 per cent using the Thompson technique.

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## CHAPTER XLV

### FIBROUS PROSTATE AND DYSECTASIA

IT has long been known that there are cases in which the symptoms of prostatic obstruction are present and yet no enlargement of the prostate can be found. So long ago as 1834 Guthrie described this condition in an article entitled, 'On the Bar at the Neck of the Bladder'. In spite of the amount of literature that has appeared on this subject much confusion still exists, mainly on account of the fact that many different pathological conditions have been included under this heading, and also that many different names have been given to it. In the French urological school it has been described as "prostatisme sans prostate," and in the American as "prostatic bar". In English literature the condition appears under the various headings of 'sclerosis of the bladder neck,' "fibrous prostate," and sometimes "prostatic atrophy."

The essential feature is the failure of the bladder neck to open, and for this reason Legueu (1931) has applied to this disability the term "dysectasia," from two Greek words meaning "difficult extension." This term, which has not yet been generally accepted, is a useful one since it distinguishes difficulties of micturition resulting from inability of the bladder neck to open from difficulties of micturition due either to obstruction or to weakness of the detrusor muscle. In order to understand the condition of dysectasia it will be helpful to refer first to the mechanism of normal micturition.

**The physiology of micturition**—Experiments on animals and clinical observation on human beings show that the opening of the bladder neck

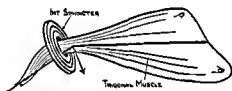


FIG 276

Diagram to show the action of the trigonal muscle in micturition. By contracting it pulls back the posterior part of the internal sphincter and brings the plane of the trigone more into line with that of the urethra.

during micturition is an active process and not merely a passive dilatation brought about by the pressure of urine. It is also a very complicated process, consisting of a series of muscular reflexes initiated by the rise of intravesical pressure. Careful study shows that when the bladder neck opens the dorsal rim of the urethrovesical orifice undergoes an eccentric displacement, which is accompanied by a backward movement of the trigone. As a result of these two simultaneous movements the angle formed by

the meeting of the plane of the trigone with that of the floor of the urethra is straightened out (Fig 276). Thus being so, the trigone slopes gradually into the urethra, and this with the relaxation of the bladder sphincter, allows the contents of the bladder to escape. Any alteration in the texture of the posterior segment of the bladder neck will interfere with its ability to open, and thus produce the same symptoms as those which are caused by prostatic obstruction.

**Pathology**—Amongst the conditions which may give rise to dysectasia and cause difficulty in micturition are adenoma of the submucous glands in

the region of the bladder neck carcinoma and the various sclerotic processes to which the bladder neck is subject. As a rule the last named of these conditions is acquired but Marion has described cases of congenital obstruction caused by an increase of muscle and of fibrous tissue in the region of the bladder neck. He has drawn a comparison between these congenital cases and the better known condition of congenital stenosis of the pylorus. But dysectasia is far more likely to be acquired than to be congenital. In some cases the thickening of the bladder neck is the result of localized adenomata or of the infiltrating hyperplasia described by Cesare Alesio and in others it is due to sclerosis. It is to these two different types of cases that the Americans apply the terms of glandular and of fibrous but various other names have been applied to this fibrous type of thickening of the posterior lip of the internal meatus: sclerosis of the bladder neck, sclerosing atrophy of the prostate and bladder (Voelkel and Wossidlo) and fibrous prostate. Sections of the bladder neck in such cases show that the muscle fibres have been replaced by dense fibrous tissue which is not confined to this region but extends also into the prostate. This structure is indeed the primary focus from which the sclerosing process has extended the changes being the sequel to previous attacks of prostatitis. The study of the fibrous type of dysectasia cannot therefore be dissociated from the study of pathological changes in the prostate. That this is so is confirmed by the fact that most patients suffering from sclerosis of the bladder neck admit to having suffered from previous attacks of prostatitis. The condition is also not infrequently associated with a urethral stricture and with chronic urinary infection.

**Diagnosis.**—The symptoms of which the patient complains are similar to those noted in cases of prostatic obstruction—difficulty in micturition, frequency, urgency, pain and a deterioration in the stream. Usually these symptoms appear at an earlier age than do those which are due to prostatic enlargement. On rectal examination no enlargement of the prostate is found and sometimes the prostate feels actually smaller than normal. Induration and tenderness may be noted and if fluid can be expressed for examination it will contain pus cells. The patient may also give a history of previous genital infections and of having been treated for a stricture.

**Differential diagnosis.**—The differential diagnosis between the various forms of dysectasia and prostatic enlargement rests chiefly on the cystoscopic examination. On passing the cystoscope some difficulty may be encountered at the moment of entering the bladder as in the case of prostatic enlargement. The amount of residual urine is first measured and the bladder is then inspected. This viscus shows the same changes that are present in the bladder of a patient suffering from prostatic enlargement: trabeculation, hypertrophy of the interureteric bar, sacculations and frequently signs of a chronic infection. On withdrawing the cystoscope and inspecting the bladder neck, no intravesical projection of the prostate is discovered. Instead there will be found a thickening of the posterior lip of the internal meatus. If some form of cystourethroscopy is being used for the examination—and this is preferable—it should now be withdrawn into the posterior urethra. Instead of there being a gradual passage of the floor of the bladder into that of the posterior urethra, there will be found to exist a sharp line of demarcation between these two structures. The observer looks down not on a floor but rather on the roof of a house, one side of which passes down steeply into the trigone and the other into the posterior urethra. The posterior lip of the internal meatus corresponding to the peak of the roof. In some cases the ridge that separates the two slopes is narrow and in some cases it is wider but it never forms the massive

of great importance, palpation of the tissues around the bladder neck. If the finger be pushed into the internal meatus a hard ridge will be felt stretched across its posterior margin. It will be found also that the meatus cannot as in a healthy bladder, be dilated. There are two possible methods of procedure—(1) the removal of a cuneiform section of the thickened posterior lip and (2) a complete excision of the neck. The first of these two operations has been described by Rubinitz, Günther and Miner. The thickened posterior lip is picked up with toothed forceps and a wedge cut out of it with scissors or scalpel. My own view is that the incision should extend to the depth of the muscular layer, for even if the sphincter be dilated control will be taken over by the external sphincter. My chief criticism of the cuneiform operation is that it can achieve no more than what can be carried out with less disturbance of the patient by transurethral methods. If therefore I find it necessary to open the bladder, I prefer to carry out the more radical excision advocated by Marion (1927). The technique of Marion's operation is as follows. When the bladder has been exposed an annular incision is made at about a centimetre's distance from the internal meatus. This is deepened until a cylinder of tissue about  $1\frac{1}{2}$  cm. in depth has been excised. The dissection is carried out with pointed scissors, a catheter being left in the urethra so as to act as a guide. Alessio and Pisani (1931) have described a connective tissue plane which leads down to the verumontanum, and have laid stress on working along this layer. Personally I have never been able to identify this in the sclerosed cases in which the operation is usually required and doubt whether it provides a useful landmark during dissection. The aim of the operator is to remove all sclerosed tissue, and if an indurated area be found outside the tissue which has been removed it should be excised separately. At the end of the excision a smooth roomy cavity is left in which bleeding points may have to be tied off. Drainage is provided for by means of an indwelling urethral catheter in addition to a small suprapubic tube. Since the danger of post-operative obstruction is greater than after a prostatectomy, metal bougies must be passed during convalescence and at increasing intervals afterwards.

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be easily accomplished by suprapubic watertight stab puncture using a Malecot tube after exposing the bladder (Fig 277). To facilitate the second stage of the prostatectomy only a small skin incision 2 to 2½ inches should be made at the first and the bladder behind the tube should be fixed to the sheaths of the recti after displacing the peritoneum upwards.

The prevesical space should always be drained when opened. The benefits of suprapubic drainage as a preliminary to prostatectomy are often equally striking both with regard to general health and in the local condition. The patient undoubtedly acquires an immunity from infection as a result of this drainage. Care must be taken in individual cases that the full benefit of the drainage has been obtained before proceeding to the second stage. For cases requiring prolonged drainage the apparatus shown in Fig 167 gives excellent results. Good supervision is of course essential. In any large series of cases of prostatic obstruction where cystostomy is performed there must

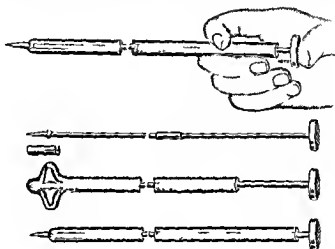


FIG 277

Wesbury White trocar and Malecot tube for suprapubic stab puncture of bladder. Sizes #6 to #8 Malecot tubes should be used.

inevitably be some who for various reasons do not proceed to the second stage of prostatectomy. It is wrong to assume because of this that all have been rejected as unfit for operation. For example in my recent series of 120 consecutive cases of simple enlargement whose bladders I opened 18 did not proceed to the second stage. The reasons for this were various and may be stated as follows:—

Died	2
Unsuitable for health reasons for further operation	3
Refused to undergo further operation (aged 83 85 91)	3
Disappeared	3
Awaiting second stage	7
<b>TOTAL</b>	<b>18</b>

**Open prostatectomy**—All operations of prostatectomy should be completed as open procedures so that bleeding points may be seen and dealt with and tags and superfluous tissue removed as required. Thoroughness in these

measures is essential when complete closure of the bladder (or of the prostatic capsule in retropubic prostatectomy) is contemplated. By following the correct technique in excising the suprapubic fistula it is generally quite a simple matter to expose to view the prostatic cavity in the second stage of prostatectomy.

**Prostatectomy with closure of the bladder**—In recent years two widely different techniques have embraced this objective. First the operation of Harris of Sydney and more recently that of Wilson Hey of Manchester.

The Harris operation includes a free use of the indwelling catheter both pre-operatively and post-operatively and compared with any other form of prostatectomy constricts the communication between the bladder and the prostatic bed. It is of course possible to carry out the operation as a two stage procedure.

The use of the boomerang needle which may easily pass outside the bounds of the prostatic capsule creates special hazards in the risks of infection. In this country most surgeons who continue to practise this operation have modified the technique according to individual fancy.

Wilson Hey on the other hand emphasizes two principles which are opposed to those advocated by Harris namely he avoids both pre-operative and post-operative urethral instrumentations as much as possible and he enlarges the communication between the bladder and the prostatic cavity. An excellent view of the latter is thus obtained. His technique by diathermy for removing the prostatic margins and stopping hæmorrhage is quick and effective. The subsequent complete closure of the bladder leading to a speedy convalescence is the final proof of the thoroughness of these measures.

Hey has advanced prostatectomy very considerably not only by showing that in the proper circumstances the bladder can be closed with safety but by putting forward abundant evidence of the evils of urethral instrumentation in connection with this operation. He believes that the damage is done by the infection which results to the bladder; others believe it arises from the deep-seated spread of infection from the walls of the posterior urethra and from the prostate. This difference in view is somewhat academic and can be usefully disregarded in the general acknowledgment of the broad measures which should be taken to forestall bad results. It is certainly striking to see the way in which some poor risk cases can be shepherded safely through this procedure. Beginners with his method will doubtless feel most comfort by starting off with their better risk cases. They will be wise to make themselves thoroughly conversant with the technique of hæmostasis and cutting by diathermy and with the risks to the rectum of these procedures before the routine is followed of completely closing the bladder.

**The retropubic (prevesical) operation**—Although the prevesical route is not new yet it has not been used much in the past. In the hands of Milin who employs it extensively it has been successful and has attracted widespread interest.

The chief advantage of this approach would seem to be the direct access to the prostatic cavity which enables the surgeon to deal effectively with all the bleeding points and to attend to the toilet generally of the prostatic bed. On the other hand the need to remove a wedge from the posterior margin of the prostatic cavity is common to all forms of prostatectomy done above the pubis where a triangular suture is not inserted. In order to safeguard the ureters in performing this incision it is essential to identify the ureteric orifices.

There is an extra hazard in the retropubic approach offered by the uncertainty of seeing these structures. The difficulty of removing a fibrous prostate by this route with the unlikelihood of getting a line of cleavage is a

potential cause of pelvic cellulitis and of suprapubic fistula. By an intravesical removal particularly that of Wilson Hey where the diathermy needle for cutting is used removal can be effected less hazardously. Millin of course recommends transurethral resection in this type of case. He speaks highly of this approach for two stage prostatectomy. Osteitis pubis and pelvic cellulitis are two complications which have been heard of frequently in connection with this method.

The proper place of the operation will in due course be established when more is known of the mortality rate, the after results and how to select the cases for the procedure.

It is obvious from the difficulties which have beset many who have ventured into this field that they should go to special pains to make themselves conversant with the operative technique and the after treatment if they are to expect good results.

**The short convalescence**—The three last mentioned procedures namely the Harris, the Hey and the Millin offer the attractive prospect of the short convalescence. The advantage of getting the patient out of bed sitting in a chair within a day or so of the operation cannot be denied. As for sending him home within ten or fourteen days of the prostatectomy certainly where urethral instrumentation has been freely used particularly in the pre-operative periods the third week of convalescence should not be regarded as the time when the danger of incidents has passed.

Because of the rejection of urethral instrumentation in the Hey technique this operation probably offers the best prospects for a smooth convalescence. No doubt time will throw more light on these matters.

The cases that go smoothly by these methods are quite dramatically successful but it must be realized that success depends upon the skill and care with which the surgeon undertakes the whole technique. It must particularly be borne in mind that because he is denied the safeguard of suprapubic bladder drainage special difficulties lie ahead of him if he has to deal with complications due to hæmorrhage or infection.

The short convalescence is a lure which must be weighed soberly against operative risks. The results obtained by two different surgeons using dissimilar methods and followed by suprapubic drainage (see below *Suprapubic Operation with Bladder Drainage*) make it clear that no advantage is to be expected in the mortality rate in comparing closed with open methods of prostatectomy.

**The suprapubic operation with bladder drainage**—It is only the surgeon who understands and has mastered all the difficulties of the technique of prostatectomy which relies entirely for post-operative bladder drainage upon a urethral catheter who can hope for success from any such method. To follow faulty manipulations by complete closure is indeed to court disaster. Because of these considerations there will always be many surgeons—perhaps a large majority—who will be wise to supplement prostatectomy with suprapubic drainage.

It is apt to be forgotten that in suprapubic prostatectomy followed by suprapubic drainage there is plenty of scope for sound and successful surgery. It is indeed only the prospect of a shorter convalescence which justifies the new procedures. The extra safety in prostatectomy conferred by preliminary bladder drainage in certain cases has already been made clear for in this way a bad risk is often turned into a good one for the subsequent prostatectomy. On the other hand the surgeon must show sound judgment in recognizing the cases which the lapse of time will not render fit enough for the second stage operation.



I find that with cases which have been carefully selected for the one stage procedure and with which pre operative urethral instrumentation—with the exception of cystoscopy immediately preceding prostatectomy—has been avoided the mortality risks can be reduced to a negligible rate. There is really no excuse for doing a poor risk case in one stage. It is the duty of every prostatectomist to make a low mortality rate his first consideration. This objective is easy to accomplish for the one stage cases because the safeguard of the two stage procedure should never be withheld from the risky or bad cases.

My last series of 102 prostatectomy cases for simple enlargement reflects this point of view for there were 42 cases of one stage prostatectomy without a death and 60 two stages with one death giving a total mortality of 0.9 per cent.

During this period there were 18 additional cystostomies with two deaths, but with the prospects of prostatectomy for many of these. Thus there were 120 cases of prostatic enlargement submitted to operation with three deaths (2.5 per cent).

Irwin has given somewhat similar figures (three deaths in 123 cases) using the two stage and Freyer method for most of them. His mortality rate indicates how sound his measures for hæmorrhage control must be for the blind operation.

The procedure common to all my 102 prostatectomy cases for dealing with the hæmorrhage was to pack the prostatic cavity with Paul's tubing after attending individually to bleeding points and the removal of tags under direct vision. More recently these steps have been much facilitated by wide removal of the prostatic margins with the diathermy needle.

Five per cent undoubtedly allows a generous margin in the mortality rate for prostatectomy and any method which yields a greater rate than this, requires to be drastically revised. The selection of cases for one stage prostatectomy is undoubtedly a process which will vary with individual surgeons, I eliminate cases with the following conditions as being unsuitable for one stage prostatectomy —

Marked chronic retention gross urinary infection vesical diverticulum with urinary infection acute retention with infected urine severe hæmaturia or clot retention chronic hæmaturia striking clinical evidence of prostatic infection certain degrees of anæmia poor general condition renal or cardiovascular disease hyperpæsiæ glycosuria

A word may usefully be said about the management of drainage tubes in a case of suprapubic prostatectomy with bladder drainage.

Freyer drained his bladders into suprapubic dressings. If this method is followed the dressing must be changed sufficiently frequently to prevent the urine from running back into the loins and on to the buttocks and sacral region otherwise bed sores will quickly supervene. This makes the daily toilet of the wound a laborious and expensive item. It is better to use an Irving's box (Fig. 188).

The lack of adequate bladder drainage is one of the important causes of infective complications. This applies to operations on the bladder in a general way. The principles to be observed in providing suprapubic drainage are as follows —

- 1 Only if hæmorrhage has been brought under complete control should a wide calibre tube not be employed at the end of the operation.

**The perurethral resection procedures**—Every urologist should strive to be expert in one of these methods. The tendency is for surgeons to be well practised in either prostatectomy or resection to the neglect of the other. Resectionists are often averse to opening the bladder yet this is an excellent safeguard when hæmorrhage is troublesome. Gaining experience in resection is an uphill road for the young urologist particularly so because he depends so much post operatively on urethral drainage. An essential need for success is a well trained team both in the theatre and afterwards in the ward. This work should therefore be carried on only in a department where all the necessary facilities exist. Doing isolated cases in scattered nursing homes is not likely to give good results.

The Mayo Clinic cold punch method has the advantage that because the cutting is done towards the bladder there seem good facilities for dealing with tags whereas cutting in the opposite direction with the electrotome makes it difficult to deal with these. The latter are a fruitful cause of secondary hæmorrhage.

Resection with the McCarthy electrotome has certainly reached a higher place than it formerly held since the recent improvement in the method of irrigation has been added to the instrument (Fig. 272).

By those who consider it necessary to do a perurethral resection for fibrous bladder neck obstruction it should be recalled that an entirely satisfactory suprapubic resection can be done for this condition with the diathermy knife. Urethral stricture should be carefully investigated at intervals post operatively.

The following fundamental disadvantages exist in the use of perurethral resection for the relief of prostatic obstruction —

- 1 In cases with large amounts of residual urine it is impossible to know *ab initio* how many resections will be required to enable the patient to empty his bladder completely.
- 2 When the bladder cannot be completely emptied subsequently to operation a persisting chronic infection of the urine is not uncommon.
- 3 In a certain number of cases obstruction recurs later from continued adenomatous changes in the remainder of the gland.

It is true that one meets with an occasional case of continued infection following prostatectomy because of a loss of tone to the bladder muscle from prolonged chronic retention which results from persisting residual urine. Such a state of affairs offers a bad prognosis. Other cases are due to diverticula which should have been dealt with or to post prostatectomy obstruction which can always be prevented.

**Post-operative prognosis**—The prognosis following recovery from removal of prostatic obstruction depends broadly on three factors —

- 1 The presence or absence of intercurrent disease before operation was undertaken.
- 2 Operative and post operative safeguards against post operative urinary tract infection.
- 3 Operative and post operative safeguards against post prostatectomy obstruction.

In the first category the most important are cardiovascular and renal disease. In the second removal of vesical diverticula and the prevention of post prostatectomy obstruction. In the third removal of an adequate amount of tissue from the field of operation after enucleation of the prostate and the proper application of post operative urethral instrumentation.

## CHAPTER XLVII

### CANCER OF THE PROSTATE

CANCER of the prostate is usually a disease of hormone imbalance a product of androgen excess and is therefore probably due to a dysfunction of the anterior pituitary sometimes it may be the result of an abnormal or modified androgen It is the first cancer known to be produced by a hormone and the first to be arrested by its opposite hormone oestrogen One hundred and sixty years ago John Hunter found that castration caused atrophy of the prostate and in the last decade of the last century castration in man was a treatment for prostatic growth and in woman for cancer of the breast The speculations of our forbears have come to fruition and opened a new vista

Cancer of the prostate is assuming greater importance now that the average age of men is rapidly increasing and because of our discovery of its great frequency It is the commonest cancer of the genito urinary tract and the commonest cancer in the body after 60 years of age If a large number of sections are taken of every prostate removed it is probable that the average pathologist would declare 17 per cent of them to be malignant

The advances both technical and biochemical during the last five years have produced so many different opinions that the present article must be considered only as an average review which is liable to change

#### PATHOGENESIS

About 85 per cent of prostatic cancers are adenocarcinomatous 10 per cent undifferentiated and 5 per cent squamous A mixture of these is common and pathologists differ as to the grouping

The adenocarcinomatous cell arranged in tubules resembles so closely the normal glandular cell that it is often missed and one pathologist will call the condition malignant and another benign A clinician may be certain of malignancy and the pathologist may deny it The pathologist misses about 35 per cent of all cases which ultimately turn out to be malignant Hence great confusion arises But for purposes of treatment if anybody considers the condition to be malignant full anti malignant measures should be taken

As would be expected the adenocarcinoma reacts best to hormone treatment and the squamous worst Undifferentiated cancer without any tubular structure at all is unaffected by stilboestrol although large quantities of acid phosphatase may be poured out into the blood The cancer is often multicentric and may be missed unless many serial sections are made

It commonly begins in the posterior and upper portion the right side being slightly commoner than the left This indicates a routine rectal examination as part of the systematic examination of all men of over middle age The middle lobe never shows primary malignancy

The growth is usually limited by the fascia of Denonvilliers the anterior layer of which should be removed in all cases of suspected malignancy The spread is upwards towards the base and seminal vesicles The urethra is far

more frequently invaded than the bladder and the rectum rarely but even the urethral or is invaded late. Spread takes place by the blood stream by the normal lymphatics and by the perineural lymphatics to the sacrum lower vertebrae and pelvic bones. The femora ribs and even skull and tibia may show secondaries. These bone metastases are commonly osteoblastic giving rise to increased density but sometimes osteoporosis may occur simultaneously. Spread may occur to the femoral inguinal and even mediastinal and supraclavicular glands.

Cancer of the prostate not infrequently produces obstruction of one or both ureters in addition to obstruction of the urethra.

### BIOCHEMISTRY

The Gutmans in 1938 showed that the prostate an essential producer of the enzyme phosphatase may produce an excess of the acid phosphatase when malignancy occurs and when bone is invaded the output into the blood stream may be tremendous even up to 1000 units per 100 c.c. Anything under 3 units is normal between 3 and 10 suggestive and over 10 units cancer is almost certain but cancer can be widespread without any appreciable rise. Testosterone elevates it stilboestrol may depress it. The level of the serum acid phosphatase is neither an indication of the estrogen dose nor a reliable index of metastatic carcinoma activity. Breast cancer with bone metastases advanced Paget's disease and hyperparathyroidism with bone involvement can also increase it. Paget's disease normally shows an elevation of alkaline phosphatase only alkaline phosphatase is caused by bone destruction. The staining methods of Gomori to indicate acid phosphatase are sometimes of value.

### THE HORMONES

Charles Huggins and others showed that androgen causes metaplasia of the prostatic epithelium stimulates cancer growth and increases the serum acid phosphatase and conversely castration in particular and synthetic oestrogens to a lesser extent diminish cancer growth and the serum acid phosphatase especially when bone metastases are present. Irradiation rarely diminishes the blood acid phosphatase. After castration androgen from the adrenals and elsewhere may still stimulate the cancer cells to activity. Adenectomy has not proved of value nor has irradiation of the adrenals or pituitary. Perhaps orchidectomy and oestrogen therapy may stimulate the adrenals and other androgen producing organs to increase their output. The writer thinks that this is the explanation of the decreasing sensitivity of the cancer to stilboestrol and therefore suggests that minimum doses just sufficient to control signs and symptoms should be used. Oestrogen is no substitute for castration it simply reinforces it.

Undoubtedly lesions resembling the gland cell histologically respond best to hormones.

### DIAGNOSIS

The symptoms are unfortunately few and occur late. They are firstly those of urination disturbances and haematuria and secondly those of metastases such as pain in the back and perineum and sciatica especially when bilateral.

Examination of the rectum (often repeated) the blood and the lower spine pelvis and femora radiologically are our chief practical helps. The cystoscope is of little value in early cases and aspiration biopsy is unreliable. Induration

of the notch between the seminal vesicles and isolated hard nodules in the posterior lobe are important suggestive signs. The enormous irregular nodular adenocarcinoma and the small stony hard fixed scirrhous are obvious. The induration of chronic prostatitis is more diffuse and there is an absence of fixation. The rectal hardness of prostatic calculi will be disposed of radiologically.

*Diœnœstrol* or *stilbœstrol* 15 mgm a day, should be given diagnostically to all suspected malignant prostates awaiting admission for operation, and if improvement occurs the most radical procedure should be carried out.

Estimations of the acid phosphatase per gramme of prostate removed have so far been only suggestive never indicative of cancer.

### TREATMENT

Treatment consists of surgery, castration and synthetic œstrogens. Each of these three methods has its exponents, but surely if we are to cure, or to produce long alleviation of, cancer we must bring all three methods into action at the earliest possible moment. It is futile to delay using one or other until metastases or untoward symptoms arise. It is true that castration and *stilbœstrol* are more likely to arrest and even temporarily heal metastases than they will the primary, and that either of these may not prevent the occurrence of metastases. It is certain that no clinical cure by either or both has yet been found.

**Surgery**—Three routes have their advocates: the suprapubic in England and the perineal and transurethral largely in America. The retropubic route is inadequate to deal with possible or definite malignancy. That which is most radical must be the best if a cure is hoped for but cures are not common except in "concealed" cancers. It is necessary therefore to operate early and radically on all so called benign prostates, and on all suspicious prostates, even without urination disturbances. It is the routine and repeated rectal examination of old men which will bring this type of case earliest to the operating table. It is rare for the prostate producing no urinary dysfunction to be removed for malignant disease.

The transurethral route would appear to be the least radical. I believe that my transvesical aseptic prostatectomy, combined with trigonectomy and vesiculectomy and, if necessary, a partial cystectomy, opening the peritoneum when necessary, can be the most radical. The malignant prostate is removed by diathermy to avoid embolic dissemination. The fascia of Denonvilliers can be cleared with safety if a naked finger is placed in the rectum in contact with its anterior wall to give warning of the approach of diathermic heat. Asepsis must be absolute.

Neither a permanent suprapubic cystostomy nor a two stage prostatectomy should ever be done. The consequent sepsis plus the cancer will hasten the patient to a miserable end. Transurethral resection can usually replace both.

**Hormones**—Evisceration (sub-capsular orchidectomy) should be performed if either the pathologist or the clinician feels certain of malignancy. I do this through a one inch incision at the bottom of the scrotum, protruding each testicle in turn and through an incision in the tunica albuginea the contents can be easily cleared. This permits minimum doses of the synthetic œstrogens and probably delays the onset of *stilbœstrol* insensitivity.

There is no known dose of *stilbœstrol*. It is advisable to use the minimum quantity consistent with arrest of cancer growth as shown by the serum acid phosphatase, skiagrams and symptoms. *Diœnœstrol* is probably preferable to

stilboestrol and although the initial dosage may be more than 15 mg a day at a very early date it should be reduced if possible to a maintenance dose of 0.3 to 1 mg daily. There is no need to give such doses as will keep the breasts and nipples permanently painful. Flushings of the face can hardly be avoided but oedema of the legs, cardiac complications, jaundice and rashes can.

In acute retention if excision is immediately done and massive doses of oestrogen are given with intermittent or permanent needle suprapubic drainage, micturition is often restored and the residual urine diminished. The prostatectomy may then be postponed to a more propitious time. This procedure can also be applied in cases of massive chronic residual urine or to make an inoperable cancer operable.

For some years I have advocated the use of thyroid extract to reinforce the synthetic oestrogen. Thyroid extract in doses which will not produce any bodily disturbance (e.g. 11 to 15 gr a day) will permit the use of smaller doses of synthetic oestrogen and so delay the on-set of insensitivity. This work has recently been confirmed in animals by Chui and Yau of Chengtu.

Irradiation has now no sound place in this disease but it should be tried where hormone treatment fails to relieve the symptoms and especially in the undifferentiated metastatic type. It is not certain to kill the interstitial cells of the testicle although it will arrest spermatogenesis.

To sum up, hopeless metastases, especially with a high serum acid phosphatase without urinary disturbance indicate testicular excision and stilboestrol or dieneestrol with urinary obstruction especially with the small scirrhus and with metastases transurethral resection, excision and dieneestrol are best. If the case is remotely curable then the widest prostatectomy, trilectomy, vesiculectomy and partial cystectomy should be done combined with castration and often a minimum maintenance dose of dieneestrol and thyroid. If dieneestrol does not relieve symptoms stilboestrol should be tried and vice versa.

The philosophy of defeatism prevails in cancer of the prostate as in nowhere else in the body—early diagnosis, radical surgery and correct hormone therapy will change this outlook.

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## CHAPTER XLVIII

### PROSTATIC CALCULI

**P**ROSTATIC calculi are found most commonly from middle life to old age

#### ÆTIOLOGY

Two classes occur —

- 1 Calculi formed in the gland acini or in a prostatic pocket communicating with the urethra such as may occur after the rupture of a prostatic abscess
- 2 Calculi found in the prostatic urethra

1 **Calculi found in the gland proper**—The normal prostate contains amyloid bodies or corpora amylacea. These are small brownish gritty bodies found in the gland acini they are laminated like starch granules they are composed of an albuminoid substance and lecithin and give the amyloid reaction with iodine. They are rounded or oval increasing in size with age till they attain the size and often the appearance of grape seeds. Several may be collected together and so become polished and faceted. By the subsequent deposit of phosphates from the urine they may form the nuclei of larger phosphatic stones. A calculus which develops in the cavity resulting from the rupture of a prostatic abscess generally has the same chemical composition as a urinary calculus.

2 **Calculi found in the prostatic urethra** are calculi which have developed in the kidney bladder or prostate and become lodged in the prostatic urethra. For further information see p. 951.

**Calcareous deposits** may be found in old standing tuberculous disease of the prostate it is important to recognize this as any surgical interference may result in acute miliary tuberculosis.

A stone may form in the prostatic cavity after prostatectomy, this may be dumb bell shaped the upper half of the stone which lies in the bladder being connected by a narrow stalk with the lower half lying in the prostatic cavity (Fig. 451).

#### DIAGNOSIS

On rectal examination a prostatic calculus may be felt as a well defined and hard rounded or angular mass in an otherwise mobile gland. When the stones are multiple crepitus and movement of the stones upon one another may be appreciated. The passage of a metal instrument along the urethra may be arrested with a characteristic sound or it may be felt to grate past the stone as it enters the bladder. Lumener stones may be present in the prostate without being detectable either on rectal examination or by the passage of a sound. The stone may be visible on posterior urethroscopy. X ray examination will define the size and number of stones present however.

**Differential diagnosis**—A carcinomatous prostate may be equally hard but is more fixed than a prostate containing calculi. An X ray examination



FIG 278

X ray showing prostate outlined with small stones within the gland



FIG 279

Prostatic calculi in a patient aged 64. 189 stones were removed by the suprapubic route, recovery was un-  
interrupted



of the pelvis will settle the diagnosis. The only other condition likely to be mistaken for a prostatic stone is an old standing tuberculous prostatitis which has undergone some calcification. The past history and the presence of other tuberculous foci, *e g* in the epididymis, will point to a correct solution.

### SYMPTOMS

CORPORA AMYLACEA may be palpable as small shotty bodies in the prostate, they give rise to no symptoms and are of no surgical importance.

STONE IN THE PROSTATIC URETHRA AND LOUCHED STONES, may give rise to no symptoms until they have attained some size. The two factors are *obstruction and sepsis*. The patient may recall a previous attack of renal colic in which no stone was passed. There may be interference with the urinary stream and even retention of urine. The patient suffers from frequency of micturition both by day and night, associated with a constant ache and sensation of fullness in the perineum. Dysuria and pyuria are present, and a little blood may appear at the beginning or, more commonly, at the end of micturition. One or more stones may be passed, and in some cases there is a purulent urethral discharge. A stone formed in the prostatic cavity after prostatectomy generally gives rise to incontinence.

### TREATMENT

Small prostatic calculi, in the absence of infection, need no interference. In the case of larger stones the indications for operation are obstruction and infection. When associated with an enlarged prostate, prostatectomy should be performed. Prostatic calculi are removed best by the suprapubic route. For removal of a stone from the prostatic urethra see p. 954.

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time to time, if a concretion occurs where the ureter crosses the vesicle, it may be closely adherent to the ureteric wall, and in such a case differentiation from a ureteric calculus may be difficult and call for repeated examinations with opaque bougies, ureterograms, and a stereoscopic technique before the exact position of the suspected shadow is established. The accurate diagnosis of vesicular shadows may be extremely difficult as it is necessary to distinguish them from phleboliths, calcified glands, and calculi of the prostate, bladder and ureter.

### COWPER'S GLANDS

**Surgical anatomy**—These tiny glands are of little clinical importance in man except as foci of infection. They are, like the prostate, accessory sex organs, are developed as outgrowths from the primitive urogenital canal, and are homologues of Skene's glands in the female. They are about the size of peas and of a dark yellow or orange colour. They lie between the apex of the prostate above and the bulb of the urethra below, one on each side of the middle line slightly behind the membranous urethra, and they are embedded in the fibres of the compressor urethrae muscle between the superficial and deep layers of the triangular ligament. If an index finger be placed in the rectum against its anterior wall and the thumb on the perineum in front of the anus, Cowper's glands will lie between them an inch or so from the anal orifice. These organs are usually impalpable by this means and only become so if enlarged by disease.

Occasionally anomalous positions of the glands have been described, and they have been found superficial to the triangular ligament between the bulb and the ischio cavernosus muscle. The ducts from these organs run for about  $\frac{1}{2}$  to  $\frac{3}{4}$  in beside the urethra, during which course they pierce the superficial layer of the triangular ligament and terminate in the lumen of the bulbular urethra.

**Physiology**—The secretion from these organs, which are active during coitus, contains mucin and an albuminous substance and is apparently squeezed along the ducts into the urethra by the action of the compressor urethrae muscle. The relative importance, however, of the prostatic vesicular, and Cowper's gland secretion is as yet not fully known and varies with the needs of the different animal species. In man the responsibility of the prostate is greatest, that of the vesicles less, and that of Cowper's glands least of all. There is a possibility that the secretion of Cowper's glands adjusts the neutrality of the urinary residue in the urethra and provides a chemically neutral passage for the spermatozoa during coitus. Complete knowledge on these matters, however, is lacking.

**Pathology**—Injuries and anomalies of these little organs are rare and are usually only found after death during carefully conducted autopsies. Sometimes during the course of urethroscopies dilated openings of Cowper's ducts have been seen in the bulbular region and have been mistaken for diverticula. Accessory ducts may also open into the urethra, producing extra orifices. Hogge (1904) described a gland, like that of Cowper, situated on the urethral bulb, and such may perhaps account for occasional cysts in the perineum occurring just behind the scrotum in the middle line and sometimes large enough to compress the urethra.

Harkness has seen a case similar to those described by Johnson (1923) and Muschat (1929) where there was a visible tumour and no urinary symptoms and he makes the following observations on the ensuing reported cases. "Many of these cases reported in the literature, including those of Elbogen (1886) and Englisch (1883), were not diagnosed until they reached the post-mortem room. Olivieri (1932) excised a large cyst from the left Cowper area

America by radiographic examinations after the injection of opaque fluids into the vesicles when it was observed that the fluid took a few days to disappear. Again the production of spermatozoa by the testes is a continuous process and during periods of sexual abstinence the former rarely appear in the urine so that they must be absorbed somewhere between the testes and the urethra. It seems probable that this absorption occurs in the vesicles though no definite proof of this has as yet been discovered.

The vesicles also produce a yellowish viscid secretion which combines with the prostatic secretion to assist in maintaining the life of the spermatozoa during their journey from the male to the female organs. Observations by Bolliger (1930) in Australia and by other workers suggest that the combined prostatic and vesicular fluids mutually serve the needs of the spermatozoa and Wallis (1922) pointed out that animals deprived of the prostate or vesicles separately can still breed but that sterility follows the removal of both organs. It would seem therefore that the prostate and vesicles have overlapping though similar functions and maintain the health of the spermatozoon after ejaculation. In man this function is mostly performed by the prostate the vesicles fulfilling a subsidiary role and being probably mainly employed in removing unwanted spermatozoa during periods of sexual abstinence.

**Congenital abnormalities**—Marked defective development of the vesiculæ seminales is rare but owing to the highly tortuous arrangement of the mucosa minor variations are numerous. When striking abnormalities are present they are often a part of a general developmental breakdown of the genito urinary system.

The vesiculae are developed as outgrowths from the primitive Wolffian system and occasionally more than one vesicle may develop on either side producing either complete vesicular reduplication or some degree of terminal bifurcation. McMahon has described separate openings of the vasa and vesicles into the urethra and developmental failure may lead to complete absence of one or both of these organs. This absence is noted perhaps more frequently on the left side than on the right.

Dilatation of the vesiculæ seminales is usually inflammatory in origin but may occasionally follow defective development. Diverticula at the junction of the vesicles with the vasa deferentia have been noted. Cysts of the vesicles may occur as the result of prenatal obstruction or they may follow defective evolution of the Wolffian and Mullerian systems. Such cavities are usually single and generally small though occasional specimens have been described which are large enough to compress the bladder and cause a palpable tumour in the abdomen.

**New growths**—These are rare and there are few recorded cases. A few instances of slow growing adenocarcinomata of one or other vesicle have been described but they rarely cause distinctive symptoms. Sarcoma of the vesicle has been noted but rarely and Young is doubtful of its existence. He and others being of the opinion that these cases are probably examples of sarcomata of the neighbouring tissues which have involved the vesicles secondarily.

**Concretions**—These are uncommon and are usually found in men of middle age on X ray examination. They are small multiple and their exact origin is unknown. The appearance and consistency of true vesicular concretions are somewhat similar to those of prostatic calculi and are often composed of closely packed masses of inspissated spermatozoa of almost stone like hardness. All these bodies are rare and must be distinguished from calcifications of collections of old inflammatory debris or as the result of previous tuberculosis. The latter may account for some of the opacities noted in younger men. From

time to time if a concretion occurs where the ureter crosses the vesicle it may be closely adherent to the ureteric wall and in such a case differentiation from a ureteric calculus may be difficult and call for repeated examinations with opaque bougies ureterograms and a stereoscopic technique before the exact position of the suspected shadow is established. The accurate diagnosis of vesicular shadows may be extremely difficult as it is necessary to distinguish them from phleboliths calcified glands and calculi of the prostate bladder and ureter.

### COWPER'S GLANDS

**Surgical anatomy**—These tiny glands are of little clinical importance in man except as foci of infection. They are like the prostate accessory sex organs are developed as outgrowths from the primitive urogenital canal and are homologues of Skene's glands in the female. They are about the size of peas and of a dark yellow or orange colour. They lie between the apex of the prostate above and the bulb of the urethra below one on each side of the middle line slightly behind the membranous urethra and they are embedded in the fibres of the compressor urethrae muscle between the superficial and deep layers of the triangular ligament. If an index finger be placed in the rectum against its anterior wall and the thumb on the perineum in front of the anus Cowper's glands will lie between them an inch or so from the anal orifice. These organs are usually impalpable by this means and only become so if enlarged by disease.

Occasionally anomalous positions of the glands have been described and they have been found superficial to the triangular ligament between the bulb and the ischio cavernosus muscle. The ducts from these organs run for about  $\frac{1}{2}$  to  $\frac{3}{4}$  in beside the urethra during which course they pierce the superficial layer of the triangular ligament and terminate in the lumen of the bulbar urethra.

**Physiology**—The secretion from these organs which are active during coitus contains mucin and an albuminous substance and is apparently squeezed along the ducts into the urethra by the action of the compressor urethrae muscle. The relative importance however of the prostatic vesicular and Cowper's gland secretion is as yet not fully known and varies with the needs of the different animal species. In man the responsibility of the prostate is greatest that of the vesicles less and that of Cowper's glands least of all. There is a possibility that the secretion of Cowper's glands adjusts the neutrality of the urinary residue in the urethra and provides a chemically neutral passage for the spermatozoa during coitus. Complete knowledge on these matters however is lacking.

**Pathology**—Injuries and anomalies of these little organs are rare and are usually only found after death during carefully conducted autopsies. Some times during the course of urethroscopies dilated openings of Cowper's ducts have been seen in the bulbar region and have been mistaken for diverticula. Accessory ducts may also open into the urethra producing extra orifices. Hogge (1904) described a gland like that of Cowper situated on the urethral bulb and such may perhaps account for occasional cysts in the perineum occurring just behind the scrotum in the middle line and sometimes large enough to compress the urethra.

Harkness has seen a case similar to those described by Johnson (1923) and Muschat (1929) where there was a visible tumour and no urinary symptoms and he makes the following observations on the ensuing reported cases.

Many of these cases reported in the literature including those of Elbogen (1886) and Englisch (1883) were not diagnosed until they reached the post mortem room. Olivieri (1932) excised a large cyst from the left Cowper area

which was assumed to be an echinococcal cyst of the left diaphragmatic gland of Cowper. There was an associated non specific urethritis and the patient, a shepherd admitted bestiality. A case of calculi in the gland with multiple urethral strictures was described by Laquiere and Bouchard in 1926. There are only six cases of primary adenocarcinoma of Cowper's glands reported in the literature—three by Lebreton (1904) and one each by Di Maio (1928) Uhle and Archer (1935) and Gutierrez (1937). In Di Maio's case there was a history of perineal injury and in the cases of Uhle and Archer and Gutierrez a previous history of gonococcal urethritis. Gutierrez's case at the time of operation was suffering from urethral stricture."

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## CHAPTER L

### THE TESTICLES

#### ANATOMY AND PHYSIOLOGY OF THE TESTICLE

THE testis in its passage through the abdominal wall acquires a covering from each layer as also does the spermatic cord. But the testicle is originally retroperitoneal and its investment in the processus vaginalis occurs differently. This structure forms a sac the tunica vaginalis into which the testicle is invaginated from behind leaving the epididymis incompletely covered. The epididymis thus serves as a broad base of attachment for the organ and so holds it in position—almost vertical—but with the upper pole tilted a little forwards and outwards. If the epididymis also becomes fully or almost fully covered in a visceral layer of tunica the organ is left not only suspended by the spermatic cord which is natural but also fixed by this point of suspension alone. This is abnormal and predisposes to torsion of the whole organ inside the vaginal sac.

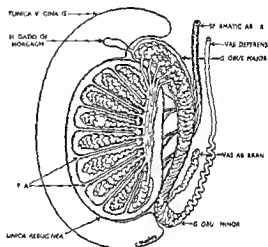


FIG 980

The testicle

The epididymis is crescentic in form and is applied to the posterior border of the corpus testis. It is expanded at its upper end into the globus major which is firmly united to the testicle by the vasa efferentia. The lower end is the globus minor united by connective tissue to the testicle firmly but not intimately. The central portion is attached to the testis only by loose areolar tissue and by the reflexion of the tunica which forms a recess on the outer side known as the digital fossa. These attachments are important in performing epididymectomy.

The vessels of the spermatic cord are distributed to the testicle over its surface via the tunica albuginea and to a lesser extent through the mediastinum testis which is entered posteriorly to the inner side of the epididymis. The epididymis can be dissected away without interrupting these vessels.

Structurally the body of the testicle consists of a firm fibrous framework in the compartments of which the 600 to 1200 seminiferous tubules are found grouped into 200 to 300 lobules. Each tubule is 1 to 3 ft in length. The tubules form collecting and straight canals which open into the rete testis a sponge work of connecting channels. This space empties through the twelve to fifteen vasa efferentia of the conus vasculosus to reach the lumen of the canal.

of the epididymis. This canal is 15 to 20 ft. long and very tortuous. At the globus minor it becomes continuous with the wider channel of the vas. This alteration in lumen determines the initial involvement of the globus minor in tuberculous gonococcal and any other variety of epididymitis, the further spread of infection along the lumen being retarded.

The seminiferous tubules are lined with cells which produce spermatozoa in such myriads that a single ejaculation may contain hundreds of millions. These cells are arranged in successive layers and are named from the basement membrane towards the lumen spermatogonia, spermatocytes, spermatids and spermatozoa. In the transition between spermatogonium and spermatocyte and between spermatocyte and spermatid the chromosomes are halved each time and one parent cell gives rise to two daughter cells.

In the finer meshes of the septa of the testicle between the tubules lie groups of the interstitial cells of Leydig. These are responsible for the internal secretion of the testicle. Ligation of the vas has no effect upon either type of cell as was previously supposed.

The adnexa are vestigial structures and are as follows —

- 1 The hydatid of Morgagni, a small body near the conus vasculosus of the globus major.
- 2 The vas aberrans of Heller—found near the globus minor.
- 3 The organ of Giraldès which lies in relation to the spermatic cord near the upper pole of the epididymis.

None of these structures communicates with the lumen of the vas or epididymis and none is apparent unless subject to cystic dilatation or in the case of the hydatid torsion.

### HORMONAL ACTIVITY

Certain anterior pituitary hormones are gonadotropic. In addition to affecting the descent of the testis they stimulate the activities both of spermatogenesis and of internal secretion (Prolan B). Consecutively the internal secretion of the testis promotes secondary sexual changes affecting the accessory sex organs but *not* the testicle itself. Indeed the injection of testicular hormone depresses anterior pituitary function and so actually diminishes the stimulation of the testicle of the individual or animal injected. It is axiomatic that no gland can be stimulated to further or greater activity by the administration of its own internal secretion.

Endocrine disturbances either primarily or indirectly in the form of depressed pituitary activity are responsible for various degrees of eunuchoidism whether occurring before or after puberty. Similarly in rutting animals seasonal changes in sexual activity follow and are initiated by changes in pituitary activity. These in turn appear to be brought about by the influence of light rather than temperature or any other climatic variation (Moore 1942). Anterior pituitary extracts are active and can be administered by injection but they are not suitable for prolonged treatment and serve only as a temporary measure.

The existence of an internal secretion of the testicle was first proved by Berthold in 1849. McGee (1927) made a successful lipid extract from bull's testicles and later Funk and Harrow (1929) extracted with chloroform an active substance from male urine. Butenandt (1931) concentrated this extract determined a formula for it and named it Androsterone. Ruzicka (1934) prepared it synthetically. David (1935) purified the extract of bull's testicle naming his substance Testosterone. Testosterone and androsterone

are similar but not identical in their action in experimental animals. Butenandt (1935) and Ruzicka (1935) next produced testosterone and androsterone respectively by synthesis. Each synthetic substance is more active when combined with certain tissue extracts (themselves inactive) and is therefore generally combined with a fatty acid the most commonly employed example being testosterone propionate. It is a very active substance and closely resembles the true internal secretion of the testicle but it is not identical with the natural product and the precise differences have not been defined.

Therapeutically testosterone propionate is administered by injection or by the subcutaneous deposition of small pellets. More recently injection of a benzene preparation has been suggested (Emmens 1941) and the efficacy of the oral administration of methyl testosterone has the testimony of several authors (Finkler and Cohn 1941 Vest and Barelare 1941 *et alia*).

### ATROPHY

Atrophy of the testicle may occur as a primary idiopathic condition or as a sequel to a number of well recognized causes namely imperfect descent, injury, torsion, inflammation, endocrine disturbance and old age. Experimentally raising the temperature of its environment also causes testicular atrophy.

Primary idiopathic atrophy is a rare condition and is more often suspected by neurotic patients than accepted as genuine. Failure of spermatogenesis without gross atrophy seems common however. Deprivation of vitamin E may cause this change. Senile atrophy which is proper to extreme old age may occur prematurely at or after 50.

The atrophy which characterizes the retained or imperfectly descended testicle resembles that which occurs experimentally when the temperature of the testis is raised (Moore 1922 *et seq*) and is probably attributable to the same cause. In this relation the heat regulating mechanism of the scrotum is important, spermatogenesis ceasing in rats when their scrota are tied up in bags resembling tea cosies. Similar results were obtained by MacLeod and Hotchkiss (1941) who exposed six healthy volunteers to a temperature of 110 degrees in a special cabinet for thirty two minutes. Between forty and seventy days afterwards the sperm counts fell below 60 000 000 per c.c. In all these cases the atrophy affects spermatogenesis to an important and to a measurable extent. The degree of impairment of internal secretion cannot be so easily measured. In general the power of internal secretion appears to remain at a satisfactory level in the retained testicle.

When atrophy occurs as a sequel to inflammatory lesions the testicle commonly becomes small and firm from interstitial fibrosis. In other cases it may be found small and soft, its structure being extensively replaced by fibro-fatty tissue.

Atrophy may follow injury by direct violence when the substance of the testicle is destroyed or so lacerated that it is later destroyed by the pressure of hæmorrhage within the tunica albuginea. Alternatively the vascular supply may be affected for example in torsion or as a result of accidental or deliberate injury in the course of an operation. Hinman (1935) states that division of the spermatic artery is almost certain to lead to atrophy but this is not universally accepted and it is even claimed that complete division of the cord high up in the inguinal canal (for the better repair of a difficult hernia) is followed by atrophy in only 50 per cent of cases (Neuhof and Mencher 1940).

Corner and Nitch (1906) believe that hypoplasia is common in varicocele and that atrophy with fibrosis is a common sequel to the operation carried



out for this condition. This is probably due to inclusion of the spermatic artery in the ligatures.

Other vascular changes recorded by McGavin (1935) and Mathe (1940) are discussed in Chapter LIII.

Hypoplasia occurs when the secretion of the anterior part of the pituitary gland is deficient and atrophy ensues when this factor defaults later in life. Individuals suffering from hypoplasia or incomplete atrophy are described as eunuchoid.

When atrophy is incomplete, spermatogenesis is usually the function which suffers most and sterility may result. When atrophy is complete and bilateral, it also affects the internal secretion and amounts in effect to castration, and the general results differ according to whether the condition arises before or after puberty.

**Treatment.**—Hypoplasia may be corrected by appropriate hormonal treatment with anterior pituitary preparations. These must be given with caution, and attention is directed to other sections dealing with this question.

**Atrophy.** Once it has begun cannot be averted, but various steps can be taken to deal with causative factors (torsion, hamatocele, etc.) before it is too late. Testosterone (*qv*) may be administered to compensate for the loss of normal internal secretion.

### CASTRATION

**Before puberty.**—In boys castrated before puberty the other sex organs fail to develop. The vesicles, prostate and penis remain small and secondary characteristics do not appear. The growth of the larynx is arrested and the voice does not deepen. The usual growth of hair on the face and trunk and in the axillæ is absent, and the pubic hair has a female distribution, i.e. its upper margin is concave upwards and does not tend to reach up towards the umbilicus. There may be abnormal deposits of fat, *eg* in the regions of the pubes, hips, buttocks and breasts. The joining up of epiphyses is delayed, but there is little tendency towards gigantism.

**After puberty.**—At this period the changes are quite different. There is no alteration in the voice or hair but there is an increase in fatty tissue. The prostate, vesicles and Cowper's glands atrophy and there is a metaplasia of their lining epithelium. The penis remains of normal size, and though impotence is usual, sexual activity is by no means necessarily impaired (Parkes, 1937, Callow, 1938), wherefore amputation of the penis is often practised in eunuchs in the East. The peculiar mental state commonly attributed to castrates is most probably due entirely to psychological trauma. The very fear of castration may produce mental symptoms whilst the glands are still perfectly normal. The writer has experience of a seaman who underwent complete castration with amputation of the penis for carcinoma of that organ. This man remained full of vigour and mentally alert, but became a burden to himself and the community because first his fellows and later his employers refused to allow him to continue his work, believing him to be physically monstrous and therefore generally unfit. The evidence appears to be entirely opposed to the inevitability of such degeneration.

From time to time patients present themselves asking to be castrated because they wish to live their lives on a more spiritual plane. The request should be refused, since such patients are already mentally unstable and psychological trouble is very likely to ensue. Medico-legally there is an explicit objection to an operation which renders the subject sterile except as a necessity on medical grounds.

efforts must be made to get a full and true picture of the trouble in the greatest possible detail. The wife should always be interviewed preferably alone. In such cases it may reasonably be assumed that the cause is largely psychological even before a full investigation has been made. Psychological treatment must then be chiefly relied upon. If a suitable specimen of semen is obtainable successful artificial insemination of the wife may inspire confidence and lead to relief.

The activity of the internal secretion of the testicle may be inferred from the general appearance of the patient and the development of the prostate. If a condom or other specimen of the ejaculate can be obtained the existence of spermatozoa may be taken as sufficient evidence of the testicle's activity including that of its internal secretion. If investigation along these lines indicates that the patient is eunuchoid or a eunuch there is a clear indication for the employment of one of the androgens. These substances are highly effective in castrates restoring the power of erection and leading to increased growth of the penis and prostate in cases in which these are not fully developed (Moore 1942). There may also be subjective changes and increase in facial hair etc. The position is constantly changing but at the time of writing testosterone propionate may be injected in oily solution or inserted under the skin in small pellets which are slowly absorbed. Emmens (1941) suggests the injection of various benzene preparations of the androgens and Finkler and Cohn (1941) and Vest and Barelare (1941) are enthusiastic about the oral administration of methyl testosterone (20 to 30 mgm daily).

When a clear case of testicular deficiency has not been made out the employment of these androgen preparations is not only useless (Creedy and Rea 1940) but may be even positively harmful. The excess of androgen depresses pituitary activity and this in turn leads to a diminution in the activity of the testicle both as regards internal secretion and spermatogenesis (Moore 1942 Spence 1940 *et al*). Seyle and Friedman (1941) on the other hand have produced some preliminary evidence suggesting that the effects of androgen therapy may be quite different when widely varying doses are employed.

The finding of blood pus or organisms in the ejaculate gives an encouraging impetus to the investigation of the case. frank prostatitis or vesiculitis may be found. A cystoscopy and urethroscopy should be carried out whenever local pathological conditions are suspected. It is common to find an abnormal condition of the verumontanum in patients in whom all the other indications point to a purely psychological explanation for the condition. This applies especially in patients who habitually masturbate or indulge in sexual excesses. It is not easy to say whether the local condition constitutes a cause or should be regarded as a result. The verumontanum is abnormally injected and may present a shaggy ragged appearance. Local treatment consists in passing bougies in instilling a few cubic centimetres of silver nitrate beginning at 1 in 1000 and increasing to 1 in 100 or in applying diathermy very lightly and delicately through the cysto urethroscope.

In the purely psychogenic cases Loewenstein (1941) has suggested the use of what he describes as a coitus training apparatus. This in effect is an unobtrusive splint which can be used until confidence is acquired when it can be discarded.

**Operation**—Lowsley and Bray (1936) in a well illustrated article based on fifty cases with two thirds successes advocate and describe an operation (Fig. 281) which is especially suitable in patients who have suffered some local injury in the perineum e.g. falls astride perineal abscesses etc. The

operation should be avoided in men over 60 whose perineal muscles are flabby and fatty and it is not suited to the relief of neurogenic or psychological cases

The rational basis of the operation is the improvement of the muscular components of erection. This is relieved by shortening the ischio-cavernosus on each side and plicating the bulbocavernosus after adequate dissection and freeing of these structures. In addition the venous return from the penis is impeded by plication of the suspensory ligament. Throughout this operation the employment of ribbon catgut in atraumatic needles is essential.

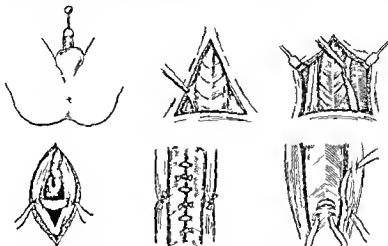


FIG. 981

Operation for impotence of traumatic origin (see text)

In general it may be said that this is a neglected branch of the urogenital surgeon's work in which patient consideration may prove of inestimable benefit. In the purely psychogenic case any trivial straw of an organic nature should be clutched at in order to give the patient something definite upon which to pin his hopes. In all cases the advantages of a holiday away from the partner for a period of weeks should be stressed also the necessity for avoiding over anxiety and over frequent attempts at coitus. Adequate physical and mental rest, a nutritious and well balanced diet, thyroid if indicated and otherwise simple tonic drugs such as strychnine and iron form the main lines of treatment.

### STERILITY

Sterility is responsible for much disappointment and unhappiness. It is a disability which may be attributable to either partner and recent figures collected over wide sections of the community in America suggest that husband and wife share the responsibility with about equal frequency. This being the case it is clearly the first duty of the physician or surgeon consulted to exonerate the man before proceeding to investigate the woman since examination of a specimen of ejaculate is a relatively simple affair which may at once indicate the defaulter.

**Ætiology.**—Sterility in the male connotes inability to procreate through failure to deliver an ejaculate containing a sufficient number of healthy

spermatozoa This inability is distinct from impotence though the two may be associated It may be due to one or more of the following main groups of causes viz —

1 Failure to elaborate sufficient healthy spermatozoa—azoospermia or oligozoospermia This may be idiopathic or due to hypoplasia or atrophy etc

2 Failure to deliver spermatozoa in the ejaculate which is largely of vesicular origin owing to some defect in the epididymis vas vesicles etc These defects are usually attributable to previous traumatic or inflammatory changes most often gonococcal more rarely tuberculous or septic (e.g. *B. coli*)

3 Failure to ejaculate (aspermia) which occurs in stricture and usually though not always after prostatectomy owing in the latter case to interference with the internal sphincter which allows the passage of the ejaculate back into the bladder Similar disability is generally held to exist after presacral neurectomy owing to removal of the motor nerve supply to the unstriated muscle of the vesicles and internal sphincter of the bladder But there is reason to doubt the truth of this belief and de Takats and Helfrich (1941) report a case in which normal sperms were found in a condom specimen four months after a most extensive sympathectomy It is of course generally held that sympathectomy does not produce impotence or interfere with libido or orgasm

Investigation—The general examination is of first importance Anaemia low blood pressure low basal metabolic rate sexual exhaustion physical fatigue emotional distress constitutional disease and endocrine imbalance etc are the things which should be borne in mind Locally evidence of injury cryptorchidism tuberculosis mumps and syphilis and gonorrhoea must be sought

In collecting a condom specimen (Dickson 1940) a washed sheath should be used as the chalk may prove harmful The specimen should be transferred to glass and kept at a low temperature and examined after an hour or two when it has become quite fluid A normal count should be 75 000 000 to 100 000 000 per c.c. and 60 000 000 or less was regarded as near the infertility line (MacLeod and Hotchkiss 1941) At or below this figure variations in form and motility are of greater significance than they are when the count is higher Monstrous forms and necrospermia of more than 20 per cent are significant Blood cells and pus cells indicate inflammation and call for further investigation Normal motility is 40 per cent at eight hours Asthenozoospermia is the term used to denote the presence of rapidly dying sperms If the forms are healthy 30 000 000 may be taken as a satisfactory count and pregnancy is not impossible with much lower figures

When spermatozoa are few in or absent from the ejaculate their elaboration in the testicle is confirmed by aspiration (Huhner 1928) More precise evidence is obtained by testicular biopsy (Charney 1940) in which the testicle is exposed by a small incision and a tiny cut made through the tunica A bead of tissue is expressed and snipped off with iridectomy scissors Sutures are inserted and a suspensory worn for twenty four hours Sections showing the structure of the tubules and the elaboration of spermatozoa give a worth while indication of the health of the testicle the prognosis and the chances of success if an anastomotic operation is undertaken

Obstructive lesions occur most commonly in the globus minor of the epididymus where the vas narrows sharply to become the epididymal tube The patency of the vas proximal to this point may be assumed or demonstrated by injecting a contrast medium This may be attempted instrumentally

through the common ejaculatory duct, or may be done by exposing and injecting the vas near its termination in the epididymis

In the presence of *hemosperma* or *pyosperma* the vesicles should be stripped separately so as to obtain differential specimens. Next the prostate is massaged for examination, and finally cystoscopy and urethroscopy are carried out. The indications for treatment depend upon the lesions thus determined.

An additional test (Huhner) of some value is a post-coital examination for living spermatozoa in a specimen taken from the cervical canal.

**Treatment**—General constitutional treatment is of the greatest value. A holiday apart for husband and wife is excellent advice. The diet should be corrected to include all the elements usually regarded as essential. The vitamin B complex is probably important, deprivation in animals leading to the absence of gonadotropic elements in pituitary extracts. Wheat germ oil—vitamin E—enjoys a popular reputation which, according to Moore (1942) lacks scientific proof. Dickson (1940) recommends 5 to 10 c.c. daily. Unfortunately, the atrophy which follows on its deprivation is irreversible and therapy only prevents further atrophy.

Among the available hormones it is generally held that testosterone is not helpful and may be positively harmful (Kreutzmann 1940, *et al.*). Anterior pituitary extracts should be helpful, and there is some recorded evidence of their efficacy (Charny, 1944). Thyroid is commonly prescribed even when not clearly indicated by a state of hypothyroidism.

Inflammatory and other lesions are treated as necessary. Stripping of the vesicles and prostatic massage may be beneficial.

Repeated sperm counts serve as a guide to the efficacy of special forms of treatment.

Obstruction of the vas, which has been shown to occur most frequently at the globus minor, may be relieved by epididymo vasostomy. Boyd (1938) claims 40 per cent successes with his technique modified from Lespinasse (1918).

**ARTIFICIAL INSEMINATION**—This is a procedure which deserves more attention. A great deal of patient work has been done in America, and Seymour and Koerner (1941) report a survey covering 9,500 successful pregnancies, mostly following a normal course. In two thirds of the cases the husband was the donor. Cary (1940) describes the technique of simple insemination and of intra uterine injection. For injection, not more than 0.6 c.c. is used. The Sim's position is employed and dorsal recumbency retained for half an hour at least. The tenth to eighteenth day of the cycle is chosen as a rule. In some cases repeated attempts are made before success is achieved. After instruction, intra vaginal insemination may be practised by the wife.

The term "semi adoption" has been coined for use when an anonymous donor is employed.

### MALFORMATIONS

Apart from structural abnormalities associated with abnormalities of position, malformations of the testicle are extremely rare.

Anorchism and monorchism have been reported *eg* by Counseller *et al* (1940) but are difficult of proof since the possibility of undiagnosed maldescent can seldom be excluded. Rea (1938) reports six probable cases and appends a bibliography.

Synorchism and polyorchism have been described, but are so rare as to be of little clinical importance.

**Reversion or retroversion** of the testicle is the name applied when the free border of the corpus testis looks backwards and the epididymis is attached in front. This is of some importance if a hydrocele develops and is to be tapped. The position of the organ can be determined by transillumination. **Inversion** occurs when the epididymis is incompletely attached. The organ may be completely upside down or may be lying horizontally. These variations predispose to torsion.

### INJURY

Considering its exposed position, injury of the testicle is a surprisingly rare occurrence. It may result from a kick, a fall astride, etc., and is always associated with intense pain of a peculiarly sickening character. Nausea or vomiting is the rule and shock may be profound. Deaths have been reported.

Four conditions may be recognized —

- 1 Closed lesions with bruising of the scrotum and more or less hæmorrhage into the testicle within the tunica albuginea.
- 2 Rupture of the tunica albuginea from gross violence. This is always associated with hæmatocele, and the detailed diagnosis is made at operation.
- 3 Incised or punctured wounds of the tunica albuginea.
- 4 Dislocation of the testicle.

**Treatment**—In *contusion*, treatment for shock is followed by local and general rest. Atrophy may ensue if the effusion within the tunica albuginea has been at all extensive. A hæmatocele should be evacuated and the testicle examined. Suture of the tunica albuginea in such a case might or might not be advisable.

*Incised wounds* should be cleaned and sutured if at all possible to avoid herniation of the tubules. The commonest cause of punctured wounds is an accidental injury when tapping a hydrocele. If serious bleeding follows, the tunica vaginalis should be opened and if necessary, the punctured wound sutured. Radical cure of the hydrocele should obviously also be undertaken.

*Dislocation* is a rare condition which calls for operative replacement more often than not. Alyea (1929) traced only twenty-three cases in the literature in a hundred and thirty years. Orchidectomy was seldom necessary.

### STRAIN

The statement is sometimes made that epididymitis and epididymo-orchitis may follow external violence—the existence of an open wound not being implied. There seems some reason to believe the truth of this statement in the presence of pre-existing infection.

The same thing applies in the case of epididymitis appearing after some unusual strain or effort at work. It is quite possible for infection to be forced down the vas in such circumstances assuming such infection to have been present at the time of the strain. There is reason to suppose that epididymitis or epididymo-orchitis (*orchite par effort*) may arise in such circumstances in a previously healthy genito-urinary tract from reflux of urine.

### TORSION OR VOLVULUS

When anatomically normal the testicle is so fixed that it cannot rotate within the tunica vaginalis. When imperfectly fixed, a condition frequently found in association with incomplete descent, rotation (or torsion) is not

uncommon The first description of the condition is attributed to Delasiauve in 1840

**Etiology**—Deficient fixation is the predisposing factor Bonomo (1933) believes it is the absence of the scrotal ligament a remnant of the guberniculum The exciting factor is anything which starts the organ twisting clockwise on the left anticlockwise on the right as a rule (Beare 1941) Either side may be affected the greatest age incidence is in infancy and between 16 and 20 (Abeshouse 1936)

**Pathology**—The imperfectly supported testicle rotates upon the vascular pedicle by which it is suspended within the tunica vaginalis It immediately becomes dusky and congested and a little blood stained fluid accumulates in the sac None of these changes is apparent until the tunica vaginalis is opened If the strangulation has been complete and has lasted a matter of hours the surface of the testicle is then seen to have lost something of its natural gloss and its colour does not improve when it is untwisted When the torsion has been present for a short time only and in cases in which the vessels have been incompletely obstructed the discoloration of the testicle is less intense and improves after untwisting Atrophy and fibrosis ensue in all except the most favourable cases

**Diagnosis**—1 As with volvulus elsewhere (e.g. the pelvic colon) recurring mild attacks are common Such mild attacks suggest the possibility of epididymo orchitis A differential diagnostic point is that in epididymitis support of the scrotum gives relief which it does not do in torsion (Prehn 1934) Initially an attack occurs worse than its predecessors

2 *An acute surgical emergency*—Alternatively the first attack may be of this character There is a tense tender swelling in the inguinal canal or scrotum which may be mistaken for a strangulated hernia The writer has seen the reverse mistake made a strangulated hernia in a young boy being mistaken for a twisted testicle The immediate appearance of a tense swelling at the very onset of the attack is characteristic of torsion Abdominal pain, nausea and vomiting occur in both conditions but are more persistent and progressive in strangulation

**Treatment**—Unwinding by manipulation has its exponents O'Connor (1933) advises this Smith (1934) reports a successful case Sorrel (1935) reports ten cases of which five did well and five atrophied It is certainly important that the volvulus should be undone as speedily as possible as recovery is unlikely after six hours and if operation cannot be undertaken manipulation is worth trying Whenever early operation is possible it is to be preferred as it offers the opportunity of fixing the organ and so of preventing a recurrence of the attack Ottenheimer and Bidgood (1933) advise fixation of the opposite testicle as well but this advice which is based on the assumption that both sides share the anatomical predisposition to torsion seems to be at variance with the facts Bilateral volvulus of the testicle is most exceptional

Cedermark (1937) records an interesting case in which the epididymis was fixed and the corpus testis only underwent torsion This was successfully undone by manipulation and later fixed by operation

### NEURALGIA TESTIS

Testicular pain may be due (1) to local changes—active or healed inflammatory disease varicocele post operative etc (2) to remote disease with pain attributed to the testicle notably ureteric or renal stones, (3) to no discoverable cause A small but troublesome group of patients constitutes this third

class and such essential or idiopathic pain is described as neuralgia testis. The patients comprising this group are mostly of a highly sensitive even neurotic type. When the ground has been cleared of the possible organic causes, psychological factors must be considered. Gross aberrations, whether sexual or of any other character may lend themselves to the advice of the practising urologist. On other occasions the medical psychologist may be better fitted to deal with the case.

## APPENDIX

The writer is indebted to Dr C V HARRISON of the Department of Pathology Liverpool University for the following notes on the examination of specimens of semen.

### 1 Collection and transport of specimen

- (1) Glass container (not condom)
- (2) As fresh as possible
- (3) Keep cold (not at 37° C)

### 2 Examination of specimen

- (1) Measure volume
- (2) Add equal volume of saline and mix well to get uniform suspension
- (3) Make wet film and estimate the percentage of motile cells (Do this at once note age of specimen. Warm slide if necessary.)
- (4) Dilute again 1/10 (or less) with Lambert Kristenson fluid. Na Citrate 1 gr. HgCl<sub>2</sub> 0.002 gr., Brill Cresyl Blue 0.20, Water 100 c.c. (not with W B C fluid). Mix well, fill counting chamber and count as for r.b.c.
- (5) Mix suitable quantity of semen with 5 c.c. saline and centrifuge. Decant supernatant and repeat. Emulsify deposit with formal saline and make films. Stain with H & E. Count 100-200 spermatozoa and estimate percentage normality (? standards).

### 3 Evaluation of results. Difficult because

- (a) Fertile semens vary enormously and
- (b) Not enough known about the limits of normal

The present figures of normality are drawn from Lane Roberts and should be regarded as tentative. In the present work standards different from Lane Roberts have been adopted.

Investigation	Average normal	Arbitrary limit (L. Roberts)	Arbitrary limit adopted
Volume	3.2 c.c.	Under 1 c.c.	Under 0.5 c.c.
Motility	70% immediate 40% at 8 hrs 30% at 24 hrs	, , ,	Under 40%
Density	100 million/c.c.	≥ 60 million/c.c.	Under 30 million/c.c.
Morphology	90% normal	Under 80%	Under 50%



## FINDINGS IN 200 CASES

Volume—Under 1 c c 15 cases (7.5 per cent) None of these showed 80 per cent normal morphology

Motility—26 condom specimens none showed any motility 153 glass specimens (excluding azoospermia)

Age	Cases showing some motility	Cases showing no motility	Proportion
0-6 yrs	25	3	9:1
6-12 hrs	14	7	2:1
12-18 hrs	7	3	2:1
18-24 hrs	4	2	2:1
Unknown	53	23	2:1

Normal motility (40 per cent motile at 8 hours) 34 suitable cases normal, 15 cases, abnormal, 10 cases

## DENSITY 200 CASES

Count in millions c c	No. of cases	Per cent	% of cases with 80% normal morphology
Azoospermia	28	14.0	—
Up to 2	7	3.5	2
3-10	16	8.0	3
11-20	12	6.0	1
21-30	14	7.0	0
31-60	21	10.5	2
Over 60	102	51.0	41

## MORPHOLOGY

Over 80 per cent normal cells 50 cases (25 per cent)  
 Under 80 per cent normal cells 150 cases (75 per cent)  
 50 "normal" cases Mean volume = 3.56 c c  
 Mean density = 155 million/c c  
 150 "abnormal" cases Mean volume = 2.98 c c  
 Mean density = 67 million/c c  
 Over 50 per cent normal cells 128 cases (64 per cent)  
 72 cases (36 per cent)

## FINAL ASSAY OF 200 CASES BY OUR STANDARDS

Total "fertile" cases	97 (48.5 per cent)
Total "infertile" cases	103 (51.5 per cent)
Cases excluded for volume only	1
" " " motility only	5
" " " density only	20
" " " morphology only	25
" " " combinations of above	52
	103

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## CHAPTER LI

### IMPERFECTLY DESCENDED AND MISPLACED TESTICLE

**DEVELOPMENT AND DESCENT**—The testis is developed from the mesoblastic tissue to the outer side of the Wolffian body behind the peritoneum in the upper part of the coelomic cavity. This mass is known as the genital ridge and as it increases in size it is provided with a mesentery—the urogenital mesentery—which extends downwards towards the groin. In the fourth month the embryonic muscular tissue of the abdominal wall buds into this mesentery and expands it with tissue which is partly muscular and partly fibrous. Above this becomes attached to the lower pole of the rudimentary testis while below it grows downwards as a solid fibromuscular mass known as the gubernaculum which extends until it reaches the subcutaneous tissue of the scrotum. As it invades and grows through the abdominal wall it carries with it a funnel-shaped protrusion from the peritoneum a covering of transversalis fascia and a layer of muscular fibres which form the cremaster, the intercolumnar fascia and the fascial layers of the lower abdomen. The gubernaculum is thus an actively growing mass of fibrous and muscular tissue attached above to the testis and below to the scrotum carrying before it a prolongation of every layer of the abdominal wall and drawing with it the peritoneum from the iliac fossa on which the testis is dragged like a log on a sledge. The descent of the testicle takes place during the later months of foetal life and should be completed by birth or shortly after.

It will thus be seen that the descent of the testis is intimately associated with its development. Failure of this process will result in imperfect descent and is likely to be accompanied by delayed or imperfect development.

**Arrested descent**—The descent of the testicle may be arrested at any level between the abdominal cavity and the scrotum. An imperfectly descended testicle is often very mobile: thus at one examination it may be in the inguinal canal while on another occasion it may be at the external ring or below it or it may even have retracted within the abdominal cavity. Several examinations may be necessary before a correct estimation of its position and mobility can be formed. It is by no means uncommon for a patient to be sent to hospital for an undescended testicle when it is not only palpable but with gentle manipulation it may be coaxed down perhaps to its normal position.

**Misplaced (ectopia) testis**—It is important to distinguish between imperfect descent and misplaced or ectopia testis. In the former there is some failure or fault in the development of testis, gubernaculum or both while in the latter the abnormal position is probably determined by some error in the attachment of the lower end of the gubernaculum. Three varieties of ectopia are recognized—

- (a) The external where the testis passes beyond the external ring but is then directed upwards and outwards towards the anterior superior spine of the ilium or directly outwards into Scarpa's triangle. It is not always easy to distinguish between this variety of ectopia and an imperfectly descended organ which can be made by manipulation to pass through the external ring.

- (b) The inferior or perineal where the testicle after traversing the inguinal canal passes to the outer side of and below the scrotum to reach the perineum
- (c) The internal where the testicle is situated in front of the pubis close to the root of the penis

**The tunica vaginalis**—The imperfectly descended testicle may be provided with a closed tunica vaginalis or more commonly this communicates with the peritoneal cavity by a patent processus vaginalis which may be wide or it may be small and difficult to recognize. In the former case there will probably be a definite hernia in the latter there is a potential hernia. In cases treated by operation a hernia or potential hernia is present in the majority of cases probably about 80 per cent.

**Physical characters of the testis**—Usually the imperfectly descended testicle is softer than normal and in unilateral cases it will be smaller than the fully descended organ. In bilateral cases both testicles as a rule will be small. The testis is usually suspended from the parietal tunica vaginalis by a mesentery which encloses the vas and the spermatic plexus. Often the epididymis is only loosely connected with the body of the testis by a short peritoneal fold.

**Testicular function**—The question of function of an imperfectly descended testicle is of great importance. It may be stated that the secretion of hormone (androgenic function) usually is normal but it is otherwise with spermatogenesis. Southam and Cooper after careful histological examination of a number of excised testes concluded that the structure of the retained testis in adolescents was very similar to that of the scrotal organ in early childhood. They concluded that development was delayed rather than absent and that the scrotal position at puberty was essential for full functional development. Even before puberty the testis may occasionally show some evidence of atrophy, and after puberty histological examination shows that either failure of spermatogenesis or atrophy of the gland is practically certain.

It follows that an adult with bilaterally undescended testicles with very occasional exceptions will be sterile. The reason for the necessity of the scrotal position for full functional development is obscure but several theories have been suggested. One view is that when the testis is within the abdomen or in the inguinal canal it is subjected to repeated slight alterations in pressure owing to the respiratory movements and that this slight but constant trauma has an adverse effect. Another suggestion brought forward by Crew (1922) is that the temperature in the scrotum is slightly less than within the abdomen and that this lower temperature may be necessary for the final stages of development. These certainly appear to be very slight causes but a slight cause acting continuously over a long time may have a very great effect upon a delicate structure such as a developing testicle.

Actual atrophy of the gland is usually attributed to repeated slight injury due to the action of the muscles especially those that flex and extend the hip joint. Full flexion of the joint must jar the testis when in the inguinal canal and occasionally in young adults walking a comparatively short distance may produce a severe and disabling attack of traumatic orchitis. Inflammation from any other cause will have a similar result. It may thus be taken as certain with possible exceptions that unless the testicle has reached the scrotum by the time of puberty or shortly after the spermatogenesis will be absent and that the testicle itself will atrophy. If one testicle only is undescended this function will be carried out by the normally placed organ but if both are undescended sterility is probable.

**Delayed descent**—Though the descent of the testicles should be completed by the end of foetal life it is a well established fact that normal spontaneous descent may occur at a much later date. The question of late descent has been investigated by R. E. Smith (1941) who systematically examined a large number of schoolboys between the ages of 9 and 19 years. He found that in a large series undescended testicles are less common as age increases. He also quotes a series of cases reported by McCutcheon (1938) who found that in 1 656 boys over the age of 15 only 13 or 0.8 per cent. had imperfect descent of one or both testicles while of 3 386 under 15 in as many as 315 or 9.4 per cent. descent was incomplete. The dividing line between the two groups is about the age of 14 and thus R. E. Smith concludes that puberty is a common time for late spontaneous descent.

**Function in relation to descent**—It has already been shown that for full functional development it is necessary for the testicle to be in the scrotum and that the final functional development takes place at puberty. These facts are of the greatest importance when the treatment and especially the most desirable age for treatment are under consideration.

**The aetiology of imperfect descent**—It has long been the opinion of the writer that there are two important factors in the aetiology of imperfect descent: (a) a developmental factor and (b) an anatomical factor that is some anatomical condition which mechanically prevents complete descent and that this anatomical cause might be secondary to or occur with the developmental failure. Recognition of these two factors is of great importance in deciding upon treatment for if there is some anatomical cause which prevents descent operative treatment to deal with the anatomical cause will be necessary. On the other hand if there is no anatomical cause to prevent descent and the condition is due to developmental failure either spontaneous descent may occur or hormone treatment should be used in the hope of aiding and stimulating the developmental process. Usually however the two factors coexist though in some the anatomical factor may preponderate to a very great degree while in others the condition may be almost entirely developmental. One may deduce from this that in some cases operative treatment alone may be indicated in others hormone treatment alone may succeed while in others a combination of the two methods will give the best results.

The most frequent anatomical condition which interferes with full descent is the presence of a hernial sac which may vary in size from a large congenital hernia to a narrow patent funicular process. Its effect can often be demonstrated at an operation by the great increase in the mobility of the testicle in a downward direction which follows removal of the sac.

Another common condition is the presence of one or more thickened bands of fascia in the sheath of the cord. These are probably secondary to the high position of the testicle and occasionally may be due to slight and repeated trauma. Complete removal or division of these bands must be carried out before the testis can be brought down into the scrotum.

Occasionally after removal of the hernial sac and division of any fascial bands an attempt to bring the testis into its normal position may be frustrated by the shortness of the vas. This is unusual before puberty but in the case of older patients it would seem that the rapid growth of the patient at this age is not accompanied by a corresponding increase in the length of the vas. Fortunately in many cases it is possible to mobilize the vas and thus to enable the testis to be brought to its correct position. Another uncommon condition is shortness of the veins. Much of what has been said about shortness of the vas applies also to the veins. The vessels may also be mobilized to a certain

extent, but great care and gentleness are necessary, for any injury to the blood supply is likely to lead to atrophy of the gland. Thickened bands in the sheath however may be confused with shortness of the veins. Abnormal attachment of the gubernaculum may also mechanically interfere with descent, but in these cases when the testis emerges from the inguinal canal it tends to pass outwards into Scarpa's triangle or outwards and upwards towards the anterior superior spine. They should therefore be regarded as cases of ectopia rather than of imperfect descent.

In cases of serious deformity of the urogenital organs such as ectopia vesicæ and the more extensive cases of hypospadias, the testicle, for obvious reasons is often unable to descend.

While considering ætiology it must be mentioned that, in rare cases, a condition indistinguishable from imperfect descent may be acquired. The following is one of two such cases seen by the writer—

About a year before admission to hospital D. W. aged 19 while working as a sawyer, strained himself severely while helping to lift a tree trunk weighing about 8 cwt. He felt a sudden pain and had the sensation of something slipping in his groin. On examining himself he found that the left testicle had disappeared from the scrotum. At the same time or shortly afterwards a swelling appeared in the left groin. The patient a sensible well developed lad was certain that, until the accident, both testicles had been present in the scrotum and that they were equal in size, also that he had never been ruptured or at any time had any swelling in the groin. His father and mother were both interviewed and they were both emphatic that during infancy and childhood both testicles had been present in the scrotum. The retracted testicle had never returned to its normal position. On admission a small hernia protruded from the external ring and the testicle which could be felt in the inguinal canal could be manipulated down to the external ring but could not be made to enter the scrotum. The right testicle was normal and the left side of the scrotum was well developed. At the operation the condition was exactly that of a typical imperfectly descended testis with a large tunica vaginalis and a wide patent funicular process. The explanation is probably that the sudden strain caused excessive contraction of the abdominal muscles associated with overaction of the cremaster. The latter drew the testicle up into the inguinal canal while the former forced the bowel into the patent funicular process. The pressure of the hernia then mechanically obstructed the return of the testicle. By the time of the operation a year after the injury secondary contractions of the fasciæ and soft parts had occurred so that the appearance of a congenital imperfectly descended testis was produced.

It is possible that a somewhat similar course of events might occur in young children and escape notice at the time.

**Complications of imperfect descent**—A number of complications which may accompany or are caused by imperfect descent of the testicle are of importance since they may cause symptoms which direct attention to the deformity, and also because it is often necessary to bring them to the notice of the parents when informing them of the necessity for treatment. Failure of full functional development with eventual *ATROPHY* and *HERNIA* have already been discussed, but it may be mentioned that an *INTERSTITIAL HERNIA* is occasionally found. These hernias are explained by the presence of the testis in the inguinal canal, where it forms an obstacle to the descent of the contents of the sac towards the scrotum thus increasing the pressure within the sac which is forced outwards between the layers of the abdominal wall. Most commonly this occurs in the subcutaneous tissue between the external oblique and Scarpa's fascia, or occasionally between the muscular layers usually between the external and the internal oblique, or very rarely into the extraperitoneal tissue between the peritoneum and the deep surface of the transversalis.

**HYDROCELE** may also occur and has to be distinguished from a hernia. The diagnosis usually presents no difficulty but owing to the probability of a patent funicular process it may be possible to reduce the fluid into the peritoneal cavity. **INFLAMMATION** may be due to injury—traumatic orchitis—the actual cause of which is compression of the testicle by muscular action or it may be due to a blow, the testis being less mobile than when normally

suspended in the scrotum. These attacks are often very disabling and may be brought on by quite trivial causes. The attacks of orchitis hasten on the process of atrophy. Orchitis or epididymo orchitis may also occur in an imperfectly descended testis as the result of the usual causes of these troubles especially a gonococcal infection. In such a case if the right testicle is retained within the abdominal cavity an attack may closely resemble appendicitis.

**Torsion** of the testicle or more exactly torsion of the spermatic cord though it may occur in a scrotal testicle is more common when the organ is undescended. The twist of the cord takes place within the tunica vaginalis. The liability of an imperfectly descended testicle to this trouble depends upon the fact that it is usually suspended by a mesentery which contains the spermatic vessels as well as the vas and its artery. The mesentery is often long and narrow so that rotation can easily take place. The symptoms are sudden onset of very severe pain accompanied by oedema and redness of the surrounding tissues which may completely mask both the testicle and surrounding structures. With this there may be constitutional disturbance shown by vomiting, pyrexia and increased pulse rate. The diagnosis may be difficult especially when it is not known that the testis is imperfectly descended. The condition may closely resemble a strangulated hernia especially when the oedema of the scrotum and adjacent tissues gives rise to a brawny swelling from which it is impossible to differentiate the testicle. Other cases may closely resemble an acute orchitis. Gangrene of the testis may occur and its removal is often necessary.

It is usually stated that an imperfectly descended testis is more liable to **MALIGNANT DISEASE** than the fully descended organ. This is doubtful and published statistics vary so greatly that a consideration of them does not help one to arrive at a definite conclusion. The writer has seen three cases in which a malignant neoplasm has developed in an imperfectly descended testicle in one of which the tumour appeared three years after a successful orchiectomy, but he has also seen three cases in which there was malignant disease of a fully descended scrotal testicle while the gland of the opposite side though undescended showed no sign of disease.

**Symptoms and signs**—In infancy and early childhood symptoms are usually absent. Indeed it is surprising how frequently parents are unaware of the deformity until their attention is drawn to it after an examination by the school medical officer. Occasionally the condition is first recognized when treatment is sought for a hernia or hydrocele. Traumatic orchitis and attacks of pain are unusual before puberty and at an earlier age the testicle is unlikely to be injured by a direct blow. Rarely torsion of the spermatic cord may be the first intimation of the condition.

After puberty the symptoms may be severe especially attacks of disabling pain and orchitis either traumatic or infective. In older children or young adults treatment may be sought for cosmetic reasons or treatment may have been advised to enable the patient to enter one of the Services or some other occupation.

Occasionally imperfect descent is associated with obesity or with Frohlich's syndrome (*dystrophia adiposogenitalis*). The trouble then is usually bilateral but R. E. Smith found that in four out of five bilateral cases of this type both testicles descended spontaneously just before puberty which was delayed. In a further unilateral case an operation for hernia at 8½ years was followed by spontaneous descent three years later. Thus the prognosis as regards spontaneous descent is not unfavourable though it is doubtful whether the spermatogenic function will develop.

**Diagnosis**—The diagnosis of imperfect descent as a rule presents no difficulty, but it is important to distinguish it from "spastic retraction of the testicle" or retractile testicle. In children the cremasteric reflex is generally well marked, but sometimes it is so greatly increased that the slightest touch, or even simple exposure of this region, will cause the testicle to be drawn up into the inguinal canal or even to disappear altogether into the abdominal cavity. These may be diagnosed as imperfectly descended testicles and sent to hospital for operation. The scrotum, however, will be fully developed, suggesting that the testicles have at times been in the correct position, and frequently a history may be obtained from the parents that this has been so. The diagnosis will be cleared up by repeating the examination on several occasions and when the testicle can be coaxed by gentle manipulation into the correct position, full spontaneous descent can be expected.

**Prognosis**—Having excluded these cases of spastic retraction, we have to consider whether it is possible to recognize those cases in which spontaneous descent will occur. R. E. Smith concludes that obesity is a favourable accompaniment and that in these cases descent usually takes place before puberty. He found that bilaterally undescended testicles nearly always descend before puberty and approximately 50 per cent of unilateral cases descend at about puberty. For full functional development the glands should then be in the scrotum. Both the date of puberty and its duration vary, but twelve years may be taken as the average age of the onset. By this time many of the cases where spontaneous descent will occur show signs that this is happening. Gentle manipulation may bring the testicle to the upper part of the scrotum, and if there is no evidence of hernia and no tight band can be felt which will hinder descent such cases may be left to Nature. On the other hand, if a definite hernia or hydrocele be present, or if there be thickening of the spermatic cord suggesting the presence of a funicular process containing fluid, or any band can be made out which definitely becomes tense on the manipulation, then spontaneous descent is very improbable and operation will be indicated.

**Treatment**—Cases of external ectopia where the testicle on leaving the inguinal canal tends to pass outwards into Scarpa's triangle or upwards and outwards superficial to the external oblique, are usually accompanied by a potential or actual hernia. They require treatment on the same lines as an undescended testicle where there is some anatomical condition which hinders descent.

When discussing treatment with the parents, especially in those cases where there have been no symptoms and when the condition has been discovered on routine examination by a school medical officer, one is often asked why any treatment is necessary. They should then be told of the complications and sequelæ which have been mentioned, particularly the failure of spermatogenesis and the probability of atrophy. They should also be told of the possibility of rejection for one of the Services or other occupation where a medical examination is required.

It has been pointed out that descent and development are closely associated and that in cases of imperfect descent there is a developmental factor and an anatomical factor. Where there is a definite anatomical cause, a hernia, for instance, orchidopexy and removal of the sac or other anatomical cause will be necessary. When the cause is wholly or mainly developmental, operation alone is unlikely to succeed and it is in these cases that hormone treatment is indicated.

**HORMONE THERAPY**—In 1927 Smith and Engle showed that injection of extract of the anterior lobe of the pituitary produced in animals a growth of all



the tissues of the testis as well as of the penis and accessory glands. These extracts are very unstable, but similar results are obtained with the gonadotropic hormone found in the urine during pregnancy and probably derived from the placenta.

A. W. Spence and E. F. Scowen in 1937 applied these facts to the treatment of imperfectly descended testicles with a considerable degree of success. Since then this treatment has been widely tried. The hormone certainly does lead to an increase in the size of both the testes and the external genitals, to such an extent that its effect in this direction has to be carefully watched. Indeed by some its success in bringing about descent has been attributed to the increase in weight of the testes.

In a recent list of cases treated by gonadotropic hormone recorded by Spence and Scowen, in which cases of spastic retraction are excluded of 38 bilateral cases 18 descended, and of 27 unilateral cases descent occurred in 9. Eleven of the remaining cases were treated by operation and in all there was some definite anatomical obstruction to descent which could only be dealt with by surgical measures. R. E. Smith states and this view is held by others, that those testicles which descend with hormone therapy are usually those which would descend spontaneously. However, the fact that we have to deal with both a developmental and an anatomical factor which coexist in varying degrees suggests the desirability of a combination of operative treatment with hormone therapy.

With certain exceptions, for example when the operation is undertaken for a definite hernia rather than for the undescended testicle, the ideal course would appear to be to give a course of hormone treatment some time before puberty. If the testicle descends, well and good, but if it does not descend, and if manipulation still shows the testicle to be insufficiently mobile, then the operation of orchiopexy should be carried out, preferably at about the age of 10-12 years.

A recent account of the anatomy and physiology of the undescended testicle together with the indications for, and the results of hormone treatment will be found in a monograph on 'The Management of the Undescended Testicle,' by P. M. F. Bishop (1945). He lays emphasis on the fact that endocrinology and surgery are not rival methods of treatment but that, in order to secure the best results they should be used in close co-operation. He considers that hormone treatment should, as a rule, be carried out when the patient reaches the age of nine years and advises that 500 international units should be injected once or twice a week until a total of 4 000 units has been given. If considered necessary a second course of treatment may be given after a short interval, or larger doses and amounts may be used. He also advocates a pre-operative course of treatment in most cases even when a hernia is present, not only to aid development of the testicle but also in the hope of overcoming any shortness of the spermatic cord.

R. E. Smith also advises a course of post-operative hormone treatment in the hope that this will help the growth of the testicle and so maintain it in its new position.

**OPERATIVE TREATMENT**—Three operative measures have been employed (1) excision of the testicle, (2) abdominal replacement (orchido-coeloplasty) in which the testicle is returned to the peritoneal cavity, and (3) orchiopexy in which the testicle is transplanted to its normal position in the scrotum. Of these, the method of choice is orchiopexy. Excision is occasionally indicated, for instance, in cases of malignant disease, for unilateral cases particularly in young adults, where the testicle is hopelessly atrophied or undeveloped.

or where, the other testicle being normal, the undescended organ cannot be brought down to the scrotum. Replacement within the abdominal cavity is very rarely performed, and should be reserved for occasional bilateral cases in which it has been found impossible to bring the organs down to the scrotum.

An important preliminary consideration is the best age for orchidopexy, and very different views have been held. The essential facts are (1) That for full development of the testis including its spermatogenic function, the gland must be in the scrotum (2) This final development takes place at puberty (3) That before puberty symptoms and complications are unusual, but after puberty these are both likely to occur and the testicle soon undergoes atrophy. Puberty is thus the important period and hence the ideal time would appear to be just before puberty. It may be argued that some cases of spontaneous descent occur during puberty or, indeed, shortly afterwards, but careful examination and gentle manipulation, especially if repeated on several occasions together with the result of a course of hormone treatment, will, as a rule, enable the surgeon to form a very good idea as to the cases in which spontaneous descent may occur.

Operation is indicated in younger boys, between the ages of 6 and 12 years, when some complication, especially a hernia, is present. Under the age of

6 years it is usually best to remove the hernial sac and leave the testicle in the hope that natural descent may occur. If this does not happen, the testicle can be dealt with at a later age.

*Orchidopexy*—In this operation the testicle and cord are exposed, the hernial sac is removed and any other anatomical hindrance to descent is dealt with, a bed is prepared in the scrotum, and measures are taken to keep the testis in position. The last is a most important part of the operation, for there is a remarkable tendency for the organ to retract to its former position.

In *trans septal orchidopexy* (Ombredanne), which will be described in some detail, the undescended testicle is brought through the median scrotal septum to the opposite side, which is occupied by the normally situated organ (Fig. 282). The

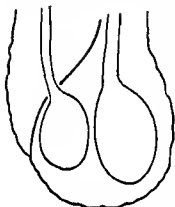


FIG. 282

Trans septal orchidopexy

advantages of this method are that no sutures are required to fix the testicle in the scrotum and that any tendency to retraction is overcome by the septum, since the small opening made for the passage of the testis contracts immediately afterwards and opposes for an indefinite time any tendency for it to return to its original position.

An incision similar to that used for a hernia operation is made to expose the external oblique and the external abdominal ring. The inguinal canal is opened up and the internal oblique is retracted in an upward direction. The cremaster is torn through to expose the spermatic cord enclosed in its fascial sheath. This is freed and drawn from its bed when gentle traction will bring the testis enclosed in its tunica vaginalis into view. The fascial sheath is opened preferably over the veins and the cord is spread out over the finger. If there has been a definite hernia the sac is soon found, but a patent funicular process may be difficult to identify when the sac is thin and when as is sometimes the case the vas and veins are partially invaginated into it, separation may be difficult, but it must be freed from other structures from the tunica vaginalis below to just above the internal ring. Just above

the internal ring the peritoneum is firmer and more elastic than the thin and friable peritoneum of the funicular process and it is here where the vas turns inwards away from the vessels that the upper ligature should be applied. As suggested by Tyrrell Gray it is also possible by putting slight traction on the cord and introducing the tip of a finger into the extraperitoneal tissue to mobilize the vas and also the vessels and thus to make it possible to bring the testis down into the scrotum without tension. The sac or funicular process is also ligatured and divided just above the tunica vaginalis and is removed (Fig 283). All tense bands in the sheath are divided so that the testis is now attached above only by the vessels and the vas. Throughout the operation

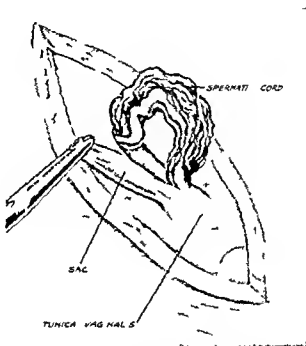


FIG 283

The sac is separated from the spermatic cord. Its upper end has been ligatured and divided.

these structures must be treated with the greatest care and gentleness. Any injury or undue tension will obstruct the blood supply and lead to atrophy.

The lower end of the tunica vaginalis is seized and the fibrous remnant of the gubernaculum put on the stretch. Firm traction will tear this away from its scrotal attachment and also avulse any bands passing outwards to Scarpa's triangle or inwards towards the pubis. This fibrous mass is now transfixed and ligatured just below the tunica vaginalis care being taken to make sure that a downward loop of the vas is not included. The ends of this ligature are left long and are secured by a pair of Spencer Wells forceps (Fig 284). It will now be possible to bring the testis down to its correct position.

The median raphe of the scrotum is identified and a short incision is made into the cellular tissue of the opposite side (Fig 285). With a blunt dissector and the tip of a finger a bed is prepared between the septum and the normally placed testis. The closed ends of the forceps holding the ends of the ligature

are pushed through the opened inguinal canal well down into the scrotum and the handle is manipulated so that the point impinges on the septum and pushes it forwards into the scrotal incision. A nick is made with a knife and through this the point of the forceps is pushed and the ends of the ligature secured. The forceps is then slowly withdrawn and the blades are separated so as to open up a channel for the passage of the testicle. Partly by pulling on the

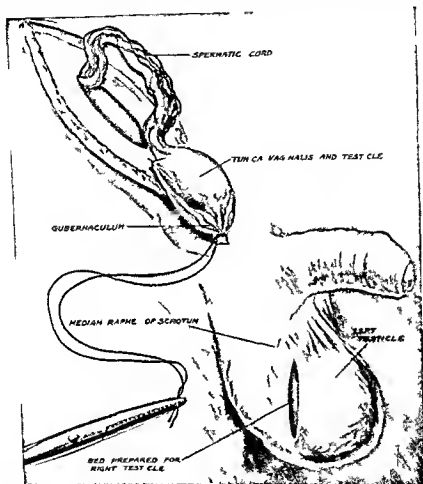


FIG 284

The fibrous lower attachment has been divided and ligatured and the ends of the long ligature secured by Spencer Wells forceps. An incision in the scrotum has been made on the opposite side of the median raphe.

end of the ligature and partly by manipulation from above the testis is drawn down along the track thus made (Fig 286). When it reaches the septum the small opening gradually dilates, the testicle slips through and the aperture in the septum immediately contracts and thus prevents retraction. The ligature is cut short and the testis is now in its prepared bed. The scrotal wound is closed with a few silkworm gut sutures, the incision in the external oblique is sutured and the wound in the groin is also closed. In bilateral cases the most favourable side is selected for the first operation. The patient is seen and examined at the end of six months and if the first operation has been a success the same procedure is carried out on the opposite side.

Tyrrell Gray, after freeing and mobilizing the testicle as described above, made a bed in the scrotum by forcing the index finger downwards from the inguinal canal. While the finger is in position a needle threaded with salmon gut is passed from without through the scrotal bed to the inguinal canal the finger acting as a guide. The needle is passed through the tunica albuginea and then again guided by the finger, pierces the scrotal bed from within



FIG. 283

The forceps have been introduced through the inguinal canal and the soft tissues so that the points press upon and push forwards the scrotal septum

outwards in close proximity to the entering stitch. Finally, the needle is passed through the skin of the inner side of the thigh and is tied over a small roll of gauze. This prevents retraction while the stitch is in position but it has to be removed in ten to fourteen days.

*Bevan's operation*—The hernial sac is removed, the testicle freed and mobilized and a bed prepared in the scrotum by the tip of the finger. The conjoint tendon is then sutured to Poupart's ligament in front of the cord and a purse string suture is inserted through the neck of the scrotum, taking up the superficial fascia and the pillars of the external ring. The aponeurosis and the skin are sutured in the usual way.

*Torek's operation*—The testicle and cord having been freed and mobilized, a bed is prepared in the scrotum and is packed with gauze. An incision about  $1\frac{1}{2}$  in long is made in the scrotum on to the gauze pack. A second similar incision is made on the inner side of the thigh where the testicle can be brought without undue tension. After the posterior lips of the scrotal and thigh incisions have been sutured together the testis is brought down through the scrotal incision and is fixed to the fascia lata by two or three sutures which

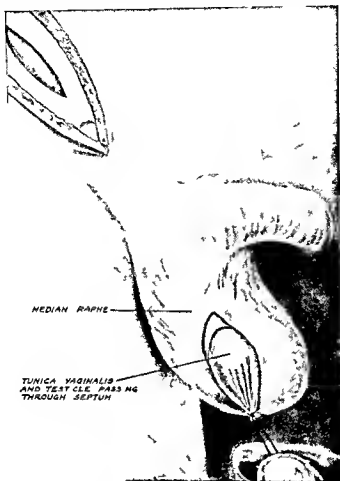


FIG 286

The testicle has been drawn through the opening in the septum

take up the tunica albuginea. The anterior lips of the thigh and scrotal wounds are now closed.

The second stage of the operation when the testis and the scrotum are separated from the thigh and both wounds are sutured, is carried out after an interval of two or three months.

Post operative symptoms and complications after orchiopexy are both infrequent and not serious. Occasionally a hæmatoma may develop, and this may sometimes become infected. The after-treatment is on the same lines as that adopted after a hernia operation.

*Results*—In an ideal result three conditions should be fulfilled. (1) The testicle should remain in its new position. (2) All complications should be

cured and all symptoms be relieved (3) The testis should increase in size and develop its normal functions With regard to the first of these conditions the testicle does remain in the scrotum in the great majority of cases and as regards size consistency and mobility becomes indistinguishable from the normally descended organ As regards complications and symptoms it may be confidently stated that any complication such as hernia hydrocele or attacks of orchitis will be cured As regards the third condition it is naturally very difficult especially when the trouble has been unilateral to speak positively as regards the function of spermatogenesis but when anatomical development is perfect it is highly probable that functional development is also satisfactory Formerly the results of orchidopexy were very poor largely owing to failure of recognition of the importance of thoroughly freeing and mobilizing the testicle and also to attempts to suture the testicle in its new bed thus running the risk of causing an orchitis likely to end in atrophy

For instance in 1908 L. B. Rawling investigated the results of orchidopexy by the older methods in 40 cases Of these 4 were fair results 3 promised favourably 8 were not traced and 25 were failures McAdam Eccles in 1903 arrived at very similar conclusions Tyrrell Gray in 1930 investigated the results in 31 cases He obtained a perfect result in 66 per cent poor result in 10 per cent and atrophy in 10 per cent Southam writing in 1927 on 50 operations in which a very similar method was employed had a successful result in 72 per cent and failure in 28 per cent

The writer in 1924 investigated the result of the trans septal operation in 50 consecutive operations The patients were examined between one and two years after the operation and the results were classified in three groups (a) The testicle is approximately the same size and consistency as the normal one it is freely movable in the scrotum and there is no induration around it or the spermatic cord 35 cases or 70 per cent (b) The testicle is of normal consistence but is either slightly smaller or situated at a slightly higher level than its fellow 8 cases or 16 per cent (c) Testicle is soft and flabby or atrophied These are failures of which there were 7 cases or 14 per cent A second series of 50 cases investigated a few years later gave almost identical figures

These results are certainly a great improvement on the results of the old operation and it may be hoped that with the combination of orchidopexy and hormone treatment future statistics will show further improvement

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## CHAPTER LII

### TUMOURS OF THE TESTICLE

**T**HIS chapter includes an account of the tumours of the testis and its intimate coverings, in addition to a description of testicular neoplasms a brief note is appended relating to the infrequent tumours of the epididymis, tunica vaginalis and tunica albuginea which invest the organ.

Testicular neoplasms constitute only 5.8 per 1,000 of all malignant tumours of males, and only one patient to every 1,500 male surgical hospital admissions (Hinman 1935)

#### TESTICULAR TUMOURS

In no field of surgical pathology is there greater confusion and disagreement than in the attempt to interpret and classify neoplasms of the testis

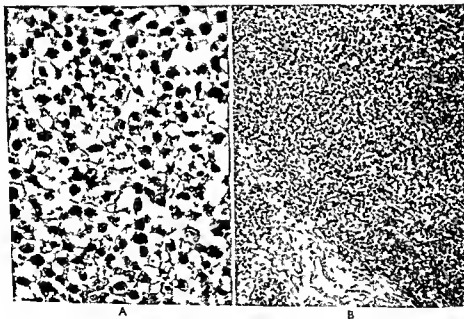


FIG 287

Seminoma High power (A) shows the large rounded nuclei of the cells with lymphocytic infiltration of the stroma Low power (B) shows homogeneous appearance of growth

The writer timidly refrains from stirring up the embers of this everlasting discussion, and in an endeavour to clarify the outlook of the clinician towards the problem has hesitatingly contented himself with separating tumours of the testis into two main classes. The more typical examples of each may be distinguishable on naked-eye inspection, but the microscope is necessarily the final court of appeal, the classification has at least the merit of furnishing a relatively sound index of prognosis. There are differences between the two



groups of tumour in respect of clinical course radio sensitivity and urinary hormones

**Seminoma**—This group of testicular tumours presents a distinct histological appearance readily recognized under the microscope the structure is relatively homogeneous and composed of sheets of cells with finely granular cytoplasm and with large somewhat rounded nuclei containing prominent acidophile nucleoli. A fine stroma and a greater or less degree of lymphatic

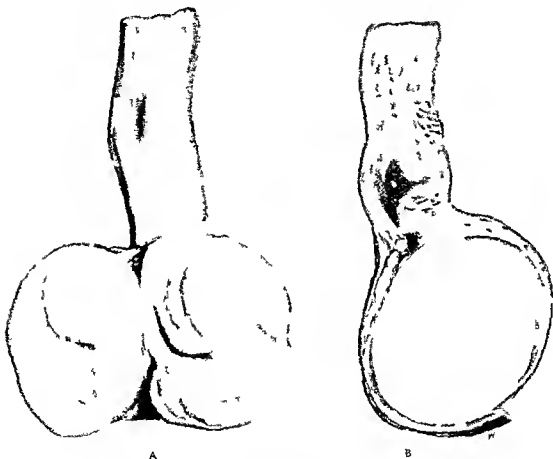


FIG. 288

Bilateral seminoma of testicle four years elapsed between the removal of each testicle from a man aged 40 (Mr Geoffrey Parke's case)

infiltration are also characteristic. This type of tumour corresponds with the *séminome* first differentiated by Chevassu (1906) and recognized by Gordon Bell (1920), Dew (1929), McDonald and Broders (1941).

**Teratoma**—All testicular tumours the histological appearance of which does not conform to the seminoma type are referred to collectively as teratomata. In the histology of this group mixed tissues cartilage tubule formation and in a small number chorionic elements are found. In a consecutive series of 32 cases 14 proved to be teratomata and 18 were seminomata (Gordon Tylor and Till 1938).

Interstitial cell tumours are very rare and constitute a class by themselves (*vide infra*)

**Age**—Testicular tumours are more precocious than those of many other organs of the body. The age incidence of the tumours of the "Middlesex" series (Gordon Taylor and Tilt 1938) corresponds almost exactly with that given by Chevassu (1906) the average age for the teratomata being 28 and for the seminomata 40 years.

**Familial incidence**—Testicular tumours have been recorded in brothers (Raven, 1934), a right testicular tumour was found in twins (Champlin, 1930). It is reasonable to think that a foetal "rest" neoplasm might occur in each of uniovular twins.

**Bilateral testicular tumours**—This condition is not very rare, Weyerbacher (1938) says 1 per cent. Bedart described the first case in 1853, and in 1930 Lewis and Priestley were able to collect fifty cases of bilateral tumour from the literature. Undescended testes are more prone to dual malignancy, which is more frequently encountered in middle age, children and patriarchs have occasionally presented themselves with this double threat to life.

Occasionally a neoplasm originates in each testicle simultaneously (Grevillius, 1937, Graves and Lawrence, 1942). In Graves and Lawrence's case one testicle weighed over 880 gm and the other 950 gm, the two tumours together weighed more than the normal weight of the liver, each was an "embryonal carcinoma". In such bilateral tumours death has soon ensued.

However, the tumour usually appears in the second testicle a month or two after operation on the first organ, Pearson's case (1932) was fortunately alive three years after the removal of two seminomata. In Geoffrey Parker's case four

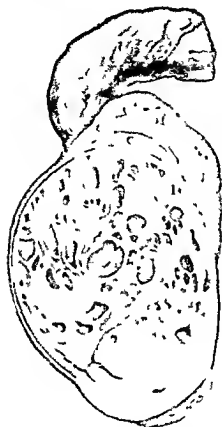


FIG. 289

Teratoma testis. An oval tumour surrounded by thin layer of testicular tissue. Tumour contained numerous cysts and showed hemorrhagic areas.

years elapsed between the two operations for bilateral seminoma (Parker, 1938).

**Polyorchidism and tumour**—Boggon (1933) was only able to collect twelve cases of accessory testicle. Handley and Crawford (1944) have added several others including one of their own. Symeonidis (1935), however, has actually recorded a teratoma of an accessory abdominal retained testis, the tumour exhibiting a predominance of chorion epitheliomatous elements.

**Orethritis of mumps and testicular tumour**—Weyerbacher (1938) reported two cases of teratoma testis that dated the beginning of testicular trouble from the orethritis of mumps four and twelve months previously, but in many the interval is far longer and any relationship dubious.

**Injury and testicular tumour**—In a Middlesex Hospital series (Gordon Taylor and Tilt, 1938) a history of injury was obtained in 20 per cent of the

cases a figure which approximates the 17.5 per cent found in Cairns's series on the other hand an association of trauma and neoplasm has been affirmed to obtain in nearly half the cases (Miyata 1913 Fetter 1941)

Injuries as diverse as a blow on the testicle from a cricket ball a knock from the shaft of a hand cart the kick of an infuriated lady and the body weight of a clumsy owner maladroitly directed have been adduced as responsible incidents by patients and in many it is difficult to escape the conclusion that the sequence of events indicated bears a definite causal relationship. Some of the cases which appear to have had a clear traumatic origin have run a hurricane course.

On the other hand sometimes an apparent causal relationship between injury and the development of a primary testicular neoplasm seems definitely



FIG. 290

Teratoma. Histological appearances exhibit the diversity of structural characteristics of this tumour.

disproved. This is well exemplified in a case of Sir James Walton which was recounted by Cairns (1926).

**Cases.**—A man was wounded in the left thigh and lower part of the scrotum by a fragment of bomb during February 1918. Four months after the injury the left testicle was found to be enlarged but the man refused surgical treatment until July 1919. At the time of operation on the right side of the scrotum was a small isolated nodule in the dartos muscle alongside one of the scrotal scars resulting from the enemy injury of a year before. The nodule was in no way connected with the right testis which was normal. The nodule in the right scrotal scar and the left testicular tumour showed the histological appearances of a seminoma.

The inference is that in this patient the testicular neoplasm was already present in the left testicle before any injury was received and that the scrotal nodule was due to malignant cells being carried to the opposite (right) side of the scrotum by a piece of metal to produce an implantation tumour.

Ceccarelli also records a case where an injury to the scrotum caused sufficient

damage to necessitate ablation of a testicle an early seminoma was found in the testis which must have been present in the organ before the injury

In some instances a history is obtained that following a relatively slight injury a testicular tumour which scarcely attracted the bearer's attention before the trauma suddenly assumed very rapid growth

**Interstitial cell tumours of the testicle**—Huffman (1941) found thirteen cases in the literature and added one of his own Somerford (1941) reported still another one of the cases was bilateral In a number of patients the malady is encountered in childhood and the testicular tumour is associated with the premature development of secondary sexual change Sometimes gynæcomasty is present One adult had suffered from impotence for some time and libido returned after orchiectomy (Hunt and Budd's case)

In Somerford's case a boy of eleven years had shaved his face for two years the secondary sexual changes may or may not undergo retrogression after orchidectomy

**Clinical varieties of malignant disease of the testicle—Type 1—Cancer of the testicle** typically develops slowly insidiously painlessly relentlessly The organ is heavy the outline may be bossy no other disease causes such early or such complete loss of testicular sensation as does a new growth There may be a hydrocele or even a hæmatocele The spermatic cord is at first normal but sometimes is thickened the vas deferens is never beaded as in tuberculosis but nodules of growth are very occasionally palpable in the spermatic cord On rare occasions infiltration of the spermatic veins by new growth has been felt

The lymphatic glands in the abdomen are often involved early the inter communication between the *juxta aortic glands* is so free that a lump may be found on the opposite side of the abdomen to the diseased testicle although the mass is more likely to be felt on the same side The *inguinal glands* are rarely implicated unless the scrotal coverings are infiltrated by the testicular neoplasm The *pilot* or *Virchow's gland* in the left supra clavicular fossa may sometimes show early enlargement

The determination of a hormone in the urine is of diagnostic as well as of prognostic value A positive test for the hormone denotes the presence of a malignant testicular growth its absence has no significance The seminoma is associated with an increased excretion of the hypophyseal hormone the teratomata are often associated with an output of chorionic hormone

In some cases the testicle may be grossly enlarged (*le testicule du taureau* of French authors) on occasion attaining the size of a child's or even an adult's head in others such as Sir Hugh Lett's case the growth only measured 2 cm in diameter at the time of operation in others the dimensions are far smaller

Where the patient seeks advice when the growth is still of small dimensions the precise testicular situation of the tumour is of diagnostic value the epididymis at this stage may be definitely separable from the lump New growths of the epididymis are extremely infrequent and are always diagnosed as testicular tumours No matter what the Wassermann reaction may be refinements of diagnosis are to be avoided any doubtful testicular swelling must be explored by surgical operation without delay

**Type 2—The "Hurricane" type of testicular neoplasm**—Some of these cases occur in men who have recently contracted gonorrhœa or indulged in sexual excesses (*pseudo inflammatory variety*) others have suffered an injury to the testicle and are perhaps first regarded as cases of traumatic orchitis (*traumatic group*)

The rate of growth may be incredibly rapid thus a merchant seaman presented himself with a gigantic testicular tumour which in about four weeks had attained the size of an adult head. This hurricane course may be encountered in neoplasms of a retained testicle as well as the normally descended organ. A patient had an inguinal testicle slightly injured by a fall from a waggon the testicle became rapidly swollen and painful and was removed by the writer employing the Gregoire Chevassu technique. Despite the radical operation the patient was in his coffin in twenty days from the operation in this patient tumours could almost be seen growing on the scalp and over the whole body on and under the skin (Gordon Taylor 1938). Frank Kidd operated on a similar case in which death ensued as dramatically fourteen days from the operation.

Badile's patient presented himself with *gonorrhœa and a testicular tumour* which had been regarded by several surgeons as of venereal nature. The tumour unfortunately proved to be a chorion epithelioma the man died twelve days later with abdominal and pulmonary metastases (Badile 1930).

A patient had contracted syphilis four years before and gonorrhœa a few weeks before coming under the writer's observation for a testicular swelling the man had also received a blow on the scrotum from a *fille de joie* the testicle grew with frightful rapidity and despite the fact that it was a seminoma death occurred in four weeks (Gordon Taylor and Till 1938).

Another man who had noticed a painless swelling of a testicle for one month experienced a sudden violent pain in the organ and some fluid was found in the tunica vaginalis two days later a still more violent pain in the testis necessitated morphia. Surgical exploration revealed blood clot in the tunica vaginalis and the testicle was found to be occupied by a new growth (Pillon and Thevenot 1935).

**Type 3—A clinical type characterized by slow testicular growth—**This type emphasizes not only the occasional slow growth of a testicular tumour but also the nonchalance of some patients. A seminoma of the testicle enlarged painlessly for five years before sudden rapid growth brought the patient to the surgeon in another case a history of four years was given by an airman who had apparently been little inconvenienced by a testicular tumour which had the dimensions of a good sized pear an enormous mass almost filling the abdomen was the means of bringing him under medical observation.

A parson vouchsafed a history of a testicular swelling which had gradually increased for ten years (E Pearce Gould). Wakeley recorded the case of a man of thirty eight years in whom a swelling of the right testicle had been present for eight years before admission to hospital. Grevilhus mentions three patients in his Scandinavian series who had known the existence of a testicular swelling for ten, fifteen and twenty years respectively before a sudden increase of growth declared itself.

**Type 4—The primary growth remains unobtrusive in size or presents no compelling symptoms—**The metastases nevertheless by reason of their multiplicity their regional distribution their enormous dimensions or the arresting symptoms which they produce dominate the clinical picture.

(a) **PULMONARY TYPE—**The patient may present himself with pulmonary symptoms the condition of the testicle may have failed to attract his attention and may only be discovered in the course of routine general examination. The X ray appearances of pulmonary nodules secondary to a malignant neoplasm of the testicle are almost diagnostic (cannon ball nodules) it is well to bear in mind Hugh H Youngs (1926) assertion that multiple

tumour nodules in the lungs in a man below 45 years are almost pathognomonic of testicular neoplasm

In some patients belonging to this pulmonary group the testicular tumour only becomes apparent later in the course of the malady. In one such case reported by Gordon Taylor and Till the diagnosis was established by X ray examination of the thorax and by a very strongly positive Friedman reaction before any testicular change was apparent.

Craven and Stewart (1936) recorded the case of a boy of fifteen years who complained of dyspnoea, pain in the right shoulder and chest and a sense of profound fatigue after exercise. A large mass was present in the chest, yet the testes were very atrophic. However 10 000 units of prolan were found in a litre of urine. Only later were two small nodules found in one of the atrophic testicles.

(b) GLANDULAR ENLARGEMENT OF NECK, AXILLA, ETC.—Sometimes the nature of the glandular enlargement secondary to a primary testicular tumour has not been established until biopsy. Gordon Taylor (1938) had one such case where there was no clinical enlargement of either testicle. Gibson and Arnold (1932) record the case of a man of 20 years who first consulted his medical adviser for a palpable mass in the left supraclavicular fossa. After a lapse of time a more thorough clinical search revealed a small nodule in the upper pole of the right testicle.

(c) MALIGNANT DISEASE OF THE TESTICLE SIMULATES AN ACUTE ABDOMEN.—In one case (Jayne and Jarrett 1943) the patient was admitted to hospital with a tentative diagnosis of perforated peptic ulcer. The man had been at work till the onset of the abdominal pain which was found after death to have been due to a hæmorrhage from a superficial metastasis in the liver into the mesocolon and to the irritation of a small blood stained effusion in the peritoneal cavity.

(d) GASTRO INTESTINAL SYMPTOMS.—These on rare occasion bring the patient with a malignant testicle under medical observation. A man of 24 years entered hospital for pain in the right hypochondrium and right renal angle (Forantzas 1930). A careful investigation at the time of admission revealed an abnormally small left testicle and normal breasts. The alimentary tract was X rayed and the man's appendix appeared to demand removal. He left hospital convalescent [*sic*] after this operation, but six weeks later the patient returned on account of rapid increase in size of the previously small left testis. The tumour was a chorion epithelioma and the disease ran a hurricane course.

Another patient came with a complaint of vague gastro intestinal disturbance of six weeks duration. Further interrogation and examination led to the discovery of an enlarged testicle which had been present for a year.

(e) BREAST HYPERTROPHY has on rare occasions been the earliest sign to attract attention (*vide p. 567*).

(f) PAIN IN THE BACK may be the symptom which first brings patient and surgeon together. This may have been present for a considerable period before advice is sought. Interrogation may elicit the information that a painless swelling of the testicle has been present unheeded for some time. In rare cases pain in the back may be the first symptom and may be due to the *dragging weight of a large tumour* to which no allusion has been made by the patient and the removal of which has at once relieved the pain. In other cases the pain in the back may be due to *osseous metastases* in the lumbar spine although secondary growths in bone were only present in 0.7 per cent of Gilbert's series. Pain in the back is sometimes alleged to indicate the

intrusion of the inferior vena cava by metastases. Finally, laparotomy has occasionally disclosed an explanation for the lumbar pain by the discovery of a seminoma of an abdominal testicle.

(g) **SEXUAL PRECOCITY**.—Sacchi records an interesting case where most of the symptoms of sexual precocity disappeared after the removal of an alveolar carcinoma of the testicle. The boy showed rapid physical and mental development at the age of 5 years. His left testicle was removed at the age of 9 years and the hair of his premature beard began to disappear within a month. The voice again assumed a childish character and retrogressive change continued in the other secondary sexual characters.

(h) **OTHER CLINICAL PHENOMENA PREDOMINATE**.—A patient came under surgical notice for a swelling of the left side of the face and a discharge of blood from the nose. The left superior maxilla after removal exhibited the histological characters of a chorion epithelioma. Subsequent investigation of the scrotum revealed a left testicle having the dimensions of a small tangerine orange. Death ensued five weeks after the appearance of the facial swelling.

*Gynecomasty* is not a very frequent accompaniment of testicular neoplasms but when present presages a clinical course of the worst omen. The condition was only noted once in a series of 100 cases analysed by Gordon Taylor and Till (1938). Quimby (1938) however refers to this state of the breasts as being fairly frequent. Cases of chorion epithelioma most often exhibit this phenomenon yet Kriss (1930) found gynecomasty present in only 5.7 per cent of this group.

The condition may be noted after the diagnosis of a teratoma of the testis has been clinically established or the phenomenon may betoken the efflorescence of metastases. On the other hand a transitory swelling of the mammae and axillary glands has been observed two months before any enlargement of the testicle (Cairns). Gynecomasty may be unilateral or bilateral the breast change being sometimes more developed in one mamma. The breasts have been known to attain the size of fists (Heidrich Fels and Mathias 1930) in this case the nipples and areolae were pigmented and the secretion from the nipples was sufficient to necessitate frequent changes of underclothing.

Histological examination of the breast tissue in cases of testicular gynecomasty reveals marked hyperplasia of the lactiferous ducts. The latter are not only more numerous than is usual in the male breast but are lined by columnar cells exhibiting active proliferation. Fat droplets have also been noted in the cells and surrounding small celled infiltration.

In addition to breast changes a testicular tumour may be associated with a histological transformation of the pituitary which may exhibit a preponderance of the clear swollen chromophobe cells which are usually related to pregnancy (Entwistle and Hepp 1935).

**Biological tests in malignancy of the testicle**.—In 1928 Aschheim and Zondek published their biological test for detecting the presence of gonadotropin in the urine of pregnant women. It was soon discovered that certain types of genital malignancy in women including hydatidiform mole and chorion epithelioma might also give a positive reaction in the urine and that the same result could also be obtained in chorion epithelioma of the testicle in the male. Heidrich and Fels (1930) were the first to report a chorion epithelioma of the testicle in a man of 30 years with gynecomasty in whom a positive Aschheim Zondek reaction was obtained. Ferguson (1934) estimated quantitatively the amount of gonadotropic hormone in the urine of patients with testicular tumour and endeavoured to correlate histology with hormone concentration in the urine.

If the test is to be utilized as a criterion of the progress of the malady it is important that it be first performed before radiotherapy or orchidectomy.

**The undescended testicle and malignancy**—The percentage of cases of undescended testicle in the male population is reckoned at a slightly different figure by various observers but probably in about 0.2 per cent of the male sex is one testis undescended. If the frequency of malignant disease of the testicle were in no way related to non descent of the organ then only 0.2 per cent of any series of testicular neoplasms ought to involve undescended testes. However Gordon Taylor (1939) found an undescended testicle to be the site of new growth in no less than 30 per cent of his series. Dean (1935) in 13.5 per cent. Miyagi (1938) in 12.4 per cent. Hinman (1933) in 12.2 per cent and Rubinschow (1936) in 11 per cent. In an analysis of 1,371 malignant tumours of the testicle Rea (1931) found an undescended gonad to be occupied by the new growth in no less than 10 per cent of his collected series—that is to say malignant disease of the undescended testicle in his analysed cases was at least fifty times as frequent as it should be if maldescent carried no increased liability.

Further suggestive evidence of the special predisposition of the ectopic testicle to undergo malignant transformation is obtainable from Gilbert's paper (1941). In patients with cancer of one testicle and unilateral cryptorchidism the ectopic organ was the organ affected in 97.5 per cent of the cases.

Amongst patients with bilateral cryptorchidism and unilateral malignancy of the testicle 24.6 per cent subsequently developed cancer in the second retained testicle whereas in patients whose testes were both in the scrotum malignancy in one was followed by cancer in the other gonad in only 0.76 per cent. Thus the frequency of bilateral malignant involvement of ectopic testicles is thirty-two times that of scrotal organs.

Not without interest are the investigations of Pace and Cabot (1936) on the histology of undescended testes removed from patients whose ages ranged between 18 and 67 years in no less than two and possibly three specimens out of twenty-four the existence of unsuspected early malignant disease was revealed.

The paucity of cases of malignant disease in testicles brought down into the scrotum by orchidopexy would appear to suggest that a protective action against malignant change in the organ attaches to operation successfully performed.

The length of the interval between orchidopexy and tumour formation which in Gilbert's series averaged as much as twelve years for a seminoma and five years for a sarcoma certainly seems to exclude operative trauma as the determining cause of malignant transformation in the vast majority of cases. On the other hand inadequate fixation or subsequent recession of the organ within the inguinal canal or abdomen has been followed by malignant change in a suggestive percentage of cases of cancer following orchidopexy (Bouchard and Laquere 1925, Marcuse 1928, Mackenzie and Ratner 1934, Deitermann 1937, Chauvin 1938, Chevassu 1935 and Clitty 1933). This finding would appear to strongly indicate the need for orchidectomy in cases where orchidopexy has failed.

Very rarely the rapidity with which testicular malignancy declares itself after orchidopexy appears to suggest a causal relationship between operation and malady. Such cases are exceptional—two have come under my own observation.

*Case 1*—A man of 39 years who had had a retained testicle in the inguinal canal all his life developed a hernia and submitted himself to a radical cure.



and orchidopexy. Within six months of operation the testicle fixed in its new environment displayed unmistakable signs of malignancy and was promptly removed. A large rapidly growing mass in the iliac fossa was submitted to radiation: the tumour was reported as a *curenomia* but may well have been a seminoma. The growth was at first dramatically radio sensitive and death was postponed for nearly twenty months after radiation therapy was commenced.

*Case 2*.—A man of 21 years had a retained testicle in the inguinal canal all his life. He was operated upon by a northern surgeon for a hernia which had recently appeared and orchidopexy was also performed. *But in three months* and before the testicle had been freed from the thigh to which it had been temporarily attached according to the Keetley Torek technique the organ exhibited indubitable signs of malignancy and was removed. Despite radiation therapy the man succumbed within six months of the orchidopexy.

**MALIGNANT DISEASE SUPERVENING IN AN INGUINAL TESTICLE REPLACED INSIDE THE ABDOMEN (ORCHIDOCLEISIS)**—Roumiti recorded a case from Fadda's clinic in Pisa where malignant disease developed in an inguinal testicle of a man of 37 years whose inguinal hernia was repaired and whose testis was replaced within the abdomen—a reprehensible procedure!

A case also came under the writer's observation where a boy of 15 years had a left inguinal testis replaced within the abdomen. Six years after the operation a large hard fixed tumour appeared in the left iliac fossa just inside the internal abdominal ring: the lower limb was swollen and cedematous and there appeared great probability that malignancy had attacked the replaced testicle. Metastases soon appeared in the thorax strongly suggestive on radiography of a testicular origin and also on the left side of the neck: these grew at a phenomenal rate and death quickly supervened. No autopsy was permitted and microscopic confirmation of the diagnosis was never forthcoming.

*In cases of malignancy following orchidopexy* there seems to be the same delay before surgical intervention that obtains in connection with scrotal testicular neoplasms: in Gilbert's series the average duration of the tumour was sixteen months yet at the time of operation 66 per cent were still operable. In 83 per cent of this very limited group of testicular tumours the neoplasm originated in a testicle which was scrotally placed: in 17 per cent the organ had been faultily placed or had receded. 57 per cent of this group of tumours were seminomata 34 per cent teratomata.

The prognosis in this type of case is worse than in malignant disease of primary scrotal testicular tumours. Only about 15 per cent of this group of cases are alive three years afterwards and only one case of seminoma and one of teratoma alive at five years.

**DIAGNOSIS OF MALIGNANCY IN THE ECTOPIC TESTICLE**—The diagnosis of a malignant tumour of an inguinal or abdominal retained testicle is not always as simple as might be imagined: some cases that pre-operatively appeared sinister have proved at operation or on microscopic examination to be of simple character: more often it happens that the sanguine hopes entertained of a favourable diagnosis are extinguished by the operative discovery of stark and fearful malignancy. The conditions enumerated below from the writer's own experience exemplify some of the conditions which may confuse the diagnosis.

(a) *Multiple fibromata and great thickening of the tunica vaginalis* of an inguinal testicle. In this case the cheerful diagnosis was only established on histological examination of the organ after removal.

(b) *Irreducible interstitial Hernia* between the external and internal oblique muscles associated with a retained testicle. This patient had been referred by an insurance company and a cautious diagnosis was made. At operation near the neck of the hernial sac of this burly patient an inconspicuously small but normal testicle was found and removed.

(c) *In abdominal testicular neoplasia* may become firmly engaged in the pelvis and may produce derangements of urination akin to those occasioned by the impaction of a fibromyoma of the uterus in the female. Such a discreditable error in diagnosis results from neglect to make a systematic examination of the hernia rings and the scrotum.

(d) *The simulation of an appendix abscess* by a malignant growth of an abdominal testicle had deceived other clinicians in two patients coming under the writer's observation. Despite the fact that there was no elevation of temperature or pulse rate, no vomiting and no intestinal derangement the diagnosis of appendicitis had been confidently predicted, the absence of a testicle on the right side had failed to be noted.

(e) *Torsion of a malignant growth of an abdominal testicle* may produce symptoms suggestive of an *acute abdominal crisis* and the sudden complication may thus be the means of drawing attention to a malignant malady. Such a case has been recorded by Finarkey, whose patient was a cryptorchid with bilateral testicular malignancy complicated by torsion and necrosis of the right organ.

**PROGNOSIS IN MALIGNANCY OF THE ECTOPIC TESTICLE**—Three personal cases of malignant disease of an *inguinal testicle* treated by inguinal orchiectomy and radiation therapy have survived operation many years, two of the cases were reported as spermatocytomata, i.e. seminomata, and a child of seventeen months had a teratoma of an inguinal testis. In the two inguinal seminomata the post-operative X-ray treatment was not administered according to modern standards, yet one survived operation twelve years before being killed in accident and the other is still alive twenty four years after an operation performed when he was 17 years of age.

The teratoma of the inguinal testis which was submitted to extensive radiation therapy after operation is still alive and well eighteen years after.

The gloom which characterizes the clinical progress of malignant disease of the abdominal testicle is relieved by one or two encouraging cases. Lecene is quoted by Aroussseau as having operated upon a man of 40 years who had acute abdominal symptoms and who on account of the absence of a testicle in the scrotum or inguinal canal was pre-operatively regarded as a case of *torsion of an abdominal testicle*. Surgical exploration revealed a malignant tumour which proved histologically to be a seminoma; the patient was alive and well over eleven years after removal.

Another long lived abdominal testicular neoplasm was operated upon by Quinby (1938). The patient was given two courses of post-operative X-ray treatment, but three years after operation a lump in the thorax caused a rib to bulge and there was evidence of pulmonary metastases in the lungs and the liver was enlarged. Intensive radio therapy was again instituted and the man was alive ten years later.

Unfortunately many such primary growths are hopelessly inoperable when they first come under surgical observation, the degree of glandular involvement precluding any protracted survival. Nevertheless Dew recorded a case where a man of 37 years had a testicular tumour retained inside the abdomen and exhibiting the tremendous size of 8 in. by 6 in. by 5 in. despite the large volume of the tumour there was no sign of metastases in lumbar

glands or elsewhere. Advanced pulmonary tuberculosis however had unfitted the patient for any operative surgery.

**ONSET OF MALIGNANCY IN THE UNDESCENDED TESTICLE AFTER HORMONE THERAPY**—Despite the feverish efforts of endocrinologists the writer can find only one case on record (Yates Bell) where a seminoma developed in an undescended testicle one year after its descent into the scrotum. The boy of 16 years had been previously to the lodgment of the testis in the scrotum tormented by repeated hypodermic injections of some gonadotropic hormone.

**Treatment of malignant disease of the testicle**—Naturally the earlier results of simple orchidectomy proved disappointing since castration can only be curative when performed before any malignant cells have been carried by lymph or blood stream to produce metastases. Wasterlain (1932) found less than 6 per cent of testicular tumours alive at four years after simple orchidectomy.

J B Roberts of Philadelphia (1902) utilizing a transperitoneal approach made the first surgical attack upon metastatic lumbar glands consequent upon a testicular neoplasm. The French school of surgery contributed most to the development of the extraperitoneal radical operation and in chronological order Raymond Gregoire (1906 1907 1908) Cuneo (1906) Chevassu (1909) and Gosset did pioneer work in this domain. Bland Sutton (1912) was not slow to seize on this radical technique which came to Britain from across the Channel.

Increasing experience of the radical procedure unfortunately disappointed the hopes which the operation first appeared to promise. The writer himself remained a protagonist of the operation until in the course of stripping the spermatic vessels lymphatics and glands downward towards the inguinal canal plaques of new growth were found on the wall of the inferior vena cava. Despite this incomplete operation radiotherapy enabled the man to live eight and a half years!

*Orchidectomy combined with radiotherapy* is the most promising method of treating testicular neoplasms. The primary growth must always be removed in order to preclude the unnecessary absorption of breakdown products of the tumour which takes place under X ray treatment and which may engender severe toxic symptoms especially if disintegration is rapid. Orchidectomy also enables an accurate histological diagnosis to be made.

X ray treatment should be employed *not* radium needles or pack. The scope of irradiation should embrace the pelvis inguinal region the homolateral lumbar glands and the glands on the opposite side of the aorta. Levitt advises that the treatment be carried out in two stages the pelvis being irradiated first and the lumbar glands subsequently with or without an interval according to the general condition of the patient. About three weeks of daily treatment are required for each part of the irradiation the total therapy lasting a period of not less than six weeks.

Radiotherapy has improved the prognosis in the radio sensitive group of the seminomata to a remarkable degree. In a certain series of twenty four cases of seminoma treated at Middlesex Hospital by orchidectomy and irradiation 50 per cent were alive at four years (Gordon Taylor and Till 1938). The prognosis in the radio resistant teratomata remained more gloomy. Eighteen in a series of thirty eight cases of every type of testicular tumour treated at St Bartholomew's Hospital i.e. 47.3 per cent were alive at five years (Payne 1939). Barringer and Earl (1941) report five year cures in 30 per cent of all testicular tumours.

The figures which emanate from the Mayo Clinic (1941) are still more encouraging in a malady which formerly ran such a malignant course. Their figures show that 47.4 per cent of seminomata are alive and well at ten years and 67.6 per cent at five years.

Even in the teratomata, 29.3 per cent were alive at five years and 26.4 per cent at ten years.

Six of the cases from that Clinic have even lived twenty years, of which four were seminomata, and two teratomata, none of these twenty cases however, had received radiation therapy.

Even in cases with metastases, if these be radio sensitive, life may be prolonged by years. 31.8 per cent of the Mayo Clinic cases with metastases lived five years, but 61.7 per cent without metastases survived five years.

The most recent figures relating to prognosis come from the writer's Skinner Lecture delivered before the Faculty of Radiologists, 15th November 1946, and are quoted here, they comprise 636 hitherto unreported cases of malignant disease of the testicle submitted to simple orchidectomy and post operative radiation.

Cases operated on up to and including 1945 i.e. cases that might have lived 1 year

Number of cases	636
Dead within year	244
Percentage dead within year	38.3

Cases operated on during the years up to and including 1943, i.e. cases that might have lived 3 years

Number of cases	520
Dead within year	273
Percentage dead in 3 years	52.5

Cases operated on during the years up to and including 1941, i.e. cases that might have lived 5 years

Number of cases	396
Dead within 5 years	218
Percentage dead at 5 years	55.5

Cases operated on during the years up to and including 1936, i.e. cases that might have lived 10 years

Number of cases	155
Dead within 10 years	118
Percentage dead at 10 years	76.1

#### PROGNOSIS BASED ON HISTOLOGY OF TUMOUR

Cases dead at end of 1 year	{ 45.6 per cent of Teratomata
	{ 39 " " " Seminomata
Cases dead at end of 3 years	{ 66 " " " Teratomata
	{ 42 " " " Seminomata
Cases dead at end of 5 years	{ 82 " " " Teratomata
	{ 47.5 " " " Seminomata
Cases dead at end of 10 years	{ 85 " " " Teratomata
	{ 73 " " " Seminomata

## BENIGN TUMOURS OF THE EPIDIDYMIS

Benign tumours of the epididymis are reckoned as constituting about one-third of the number of solid tumours of the epididymis. The relatively large percentage of benign solid growths amongst neoplasms of the epididymis is in fortunate contrast to the meagre proportion of testicular tumours of innocent character.

*Leiomyoma* constitutes the most frequent variety of this rare group of benign growths of the epididymis. Thirteen cases were collected by Friedman and Grayzel (1942), Gordon-Taylor reports a more recent example (1943).

The history is obtained of a gradual painless increase of an intrascrotal swelling, although occasionally intermittent pain may have been noted. The tumour is most frequently situated in the *globus major* or *minor*, rarely in the



FIG. 201

Adenoma of Epididymis. Microphotograph showing a portion of the epididymis, the convolutions of its tubular structure being lined by high columnar epithelium. Alongside this are portions of the tumour, which consists of a mass of tubules with much smaller lumina than those of the tissue of origin.

corpus of the epididymis; it is round or ovoid, firm to stony-hard in consistency, nodular and usually not tender. An associated *hydrocele* is present in 50 per cent of the cases.

Correct diagnosis has rarely been attained pre-operatively; the cases are often regarded as testicular neoplasms and submitted to orchidectomy. At the time of operation the tumours vary in size from a diameter of  $\frac{1}{2}$  in. to the volume of a tangerine orange.

The tumours originate in smooth-muscle cells found in the epididymis. No malignant change has been recorded in any epididymal leiomyoma, and no recurrence has followed operation. The appropriate form of surgical treatment should be *epididymectomy*.

On two occasions the patient has presented himself with a bilateral leiomyoma (Milner and Gilbert, 1939; Foged, 1940).

Lymphangioma is said to constitute about 27 per cent of all benign tumours of the epididymis. This is a benign congenital tumour. Pain from pressure of the growing tumour on adjacent structures and the development of a hydrocele are the only clinical features.

Angioma of the epididymis has been recorded by two British observers both were cavernous angiomas (A. L. d'Abreu 1936 J. P. Hosford 1931).

Adenoma has been recorded by Gordon Taylor and Onimoney Davis (1941) and by Blumer and Edwards (1941). In each case the adenoma was related to the lower pole of the epididymis. Thompson records a cystic adenoma (1936) and Sakaguchi an adenomyoma (1915).

A single case of each of the following benign tumours of the epididymis has been described: fibromyoma (Eisenstaedt 1913) lipoma (Wildbolz 1914) dermoid cyst (Votta 1936) a mixed lymphangioma and leiomyoma (Halpert 1941) and a pericanalicular fibroma (Backer Grendahl 1937). There is said to be no case of pure fibroma of the epididymis in the literature. Any alleged tumour of this nature originates from the caudal portion of the spermatic cord (Friedman and Grayzel 1942).

### MALIGNANT DISEASE OF THE EPIDIDYMIS

At least 60 per cent of solid tumours of the epididymis are malignant. Yet neoplasms are uncommon: only ninety-two cases having been collected by O'Brien (1942). There is some conflict of opinion whether carcinoma or sarcoma is the more frequent. Carcinoma is most often of a glandular type (Ferner and Ford 1934). Rowlands and Nicholson's case of squamous celled epithelioma of the epididymis is world famous (1909). A histological report of teratoma or seminoma betokens an invasion of the epididymis by a primary testicular tumour.

*Secondary malignant disease of the epididymis* has been known to occur only three cases are recorded in the literature (Henke and Lubarsch 1925, Dermian 1927, Katzen 1941). The first two were secondary to a renal tumour; in the third case the primary growth was an adenocarcinoma of the stomach.

Most frequently the patient with malignant disease of the epididymis comes under observation for a recurring collection of fluid in the tunica vaginalis. Many of the patients have been middle aged or elderly men, one having attained the age of 73 years. The new growth is often considerable at the time of operation: thus in Oldham's case (1936) the tumour measured  $2\frac{1}{2}$  in long by 1 in in diameter. On the other hand in Coleman's patient (1932) the epididymis was only slightly enlarged.

The clinical course of the malady is frequently rapid. In O'Brien's case (1942) of a fibrosarcoma of the epididymis which followed a violent blow on the scrotal region the progress of the malady was of a hurricane type.

The usual sites of metastasis in malignant disease of the epididymis correspond with those associated with neoplasms of the testicle and in most cases lymphatic spread precedes venous dissemination. Even the skeleton may be selected for osseous metastases, especially the lumbar vertebrae but more distal bones have been attacked.

### TUMOURS OF THE TESTICULAR TUNICÆ

Fortunately 60 per cent of these new growths are benign. Fibromata may arise from the subserous tissue of the tunica vaginalis or may originate in the tunica albuginea investing the testis. Four fibromata of the tunica

*albuginea* were collected from the literature by Thompson (1936) three were summarily dealt with by orchidectomy the fourth was well encapsuled and enucleation of the tumour was possible

The *tunica vaginalis* has been found thickened in almost all the cases of

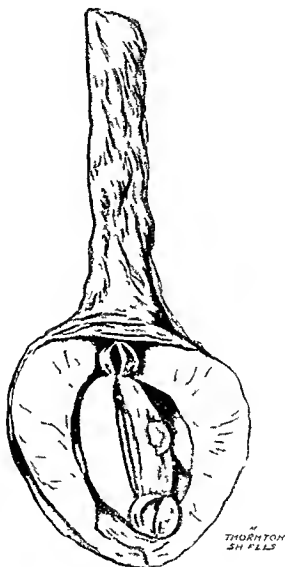


FIG. 232

Multilobular fibroma of the tunica vaginalis of an incarcerated testis (p. 109) (from the collection of the author)

*fibroma* or *fibromata* growing from the subserous layer of the tunica vaginalis. The growth may appear in single or multiple form sometimes even a hundred or more tumours have been present (Ball 1941). In Ball's case the tunica vaginalis was converted into a thickened gelatinous mass. In Gordon Taylor's (1934) patient the parietal layer measured  $\frac{3}{4}$  in at its thickest part. The microscopic appearance of the thickened tunica in this last case suggested

a chronic inflammatory process, and the name of "periorchitis prolifera" has been coined for this association of fibromata and thickened tunica. In Ball's case the specimen weighed 120 gm.

**Lipoma**—Gibson found only three cases of lipoma in the literature, yet one tumour weighed 3 lbs (Park, 1886). Deming's case (1933) was bilateral.

**Adenoma**—Three cases of this tumour are on record, and five of myoma, which probably arose in the gubernaculum.

**Endothelioma and lymphangio-endothelioma** have also been reported.

**Malignant tumours of the tunica vaginalis**—These are rare, impossible to diagnose from testicular tumours, sarcomatous in nature and attack the youthful; the oldest patient in Rubaschow's (1926) series was only 35 years of age.

It is worth while remembering by way of contrast that sarcoma of the spermatic cord rarely occurs in young men.

GORDON GORDON TAYLOR

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## CHAPTER LIII

### TUNICA VAGINALIS

THE development and anatomy of this structure have been described in Chapter XLV. Developmental variations are of some importance in the interpretation and classification of hernia and hydrocele.

Unfortunately the nomenclature in hernia and hydrocele hitherto employed is not very helpful to the student who needs to memorize these anomalies, which are illustrated in Fig. 293.

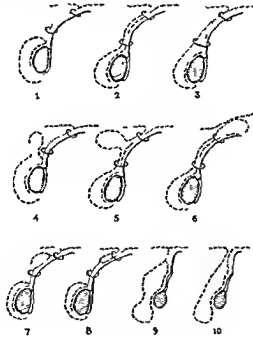


FIG. 293

Varieties of hydrocele of the processus vaginalis —

- 1 Vaginal
- 2 Congenital
- 3 Infantile
- 4 Bilocular (hydrocele en bissac)
- 5 Interstitial
- 6 Bilocular abdominal
- 7 Hydrocele of the cord
- 8 Hydrocele of hernial sac
- 9 Hydrocele with imperfect descent
- 10 Congenital sac with imperfect descent

(The circles denote the position of the internal and external rings.)

## HYDROCELE

Hydrocele is a term which is used to cover a number of different conditions. The unqualified term hydrocele refers to hydrocele of the tunica vaginalis which may be —

- 1 Symptomatic—acute and chronic
- 2 Idiopathic

**Symptomatic hydrocele**—In symptomatic hydrocele fluid collects as a result of injury or of inflammatory changes in the body or epididymis of the testicle. The acute or chronic nature of the inflammatory change is reflected in the rapidity of onset and the nature of the fluid found in the sac. This may be clear and straw coloured or may contain blood cells pus cells organisms flakes of fibrin etc. When a congenital sac occurs in a patient with a peritoneal exudate *e.g.* in tuberculous peritonitis the fluid found in the sac is continuous with that in the peritoneal cavity.

*Symptomatic hydrocele is of diagnostic significance and is considered in relation to the various conditions in which it is found. Its treatment is linked with that of the causative lesion. Similarly empyema of the tunica vaginalis occurring as a sequel to symptomatic hydrocele may respond to the special treatment indicated by the ætiology. On other occasions it may call for incision and drainage.*

Hydrocele may be caused by injury applied as direct violence or by torsion of the testicle or of the hydatid of Morgagni. In such cases blood cells are generally found in the hydrocele fluid. More severe injury causes hæmatocele.

Symptomatic hydrocele caused by mild degrees of inflammation or by injuries insufficient to cause hæmatocele may become established as a chronic collection of fluid long after the original cause has ceased to be recognizable. Such cases cannot be distinguished from the idiopathic variety.

**Idiopathic vaginal hydrocele**—*MORBID ANATOMY*—The tunica vaginalis is distended with ounces pints or even gallons of a clear straw coloured fluid closely resembling normal urine in its appearance. This *hydrocele fluid* has a specific gravity of 1022 to 1026. It contains 6 per cent albumen—serum albumen and serum globulin—and fibrinogen. This does not coagulate unless blood is added as the necessary ferment is absent. Cholesterol may be present in quantities visible to the naked eye or in microscopic amounts together with endothelial cells and an occasional leucocyte and red cell. Loose bodies may form and may be fibrinous or calcified. The wall of the hydrocele may be quite smooth and thin or it may be thickened with or without some roughening of its surface especially over the testicle (Fig 294). The fluid is probably an exudate rather than a transudate. This is suggested in part by its composition and in part by the rarity of the occurrence of hydrocele in association with varicocele.

Atrophy of the testicle may ensue in neglected cases though whether from pressure or interference with the heat regulating mechanism of the scrotum is not known.

**DIAGNOSIS**—The affected side of the scrotum is enlarged and the testicle completely obliterated. The upper limit of the swelling can be clearly defined which differentiates it from hernia. The swelling transilluminates clearly except at the point of attachment of the testicle. Ordinarily this is below and behind but this point must be checked before tapping is attempted. In cases of long standing the structures of the cord are palpably increased in bulk mainly from increase in the strength of the cremaster muscle.

TREATMENT is sought for the relief of the inconvenient swelling and should be advised in most cases. The three methods available are —

- 1 Intermittent tapping
- 2 Tapping and injection
- 3 Open operation

*Tapping*—The position of the testicle is determined by transillumination. A suitable area is then cleaned and infiltrated with novocain. A fine sharp trocar and cannula is used care being taken to avoid wounding the surface of the testicle. If a serum needle is used instead of a trocar and cannula there is greater risk of this form of injury which is a common cause of hæmatocele. The trocar and cannula should be passed firmly into the sac for about an inch.

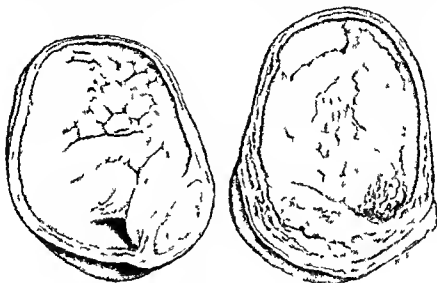


FIG. 994

Bilateral calcification of hydrocele sacs from a man aged 72 who died of cerebral hæmorrhage (Mr H. M. Matheson's case).

The trocar is then withdrawn and the cannula pushed as far as possible preferably up to the shield and held in that position. This technique prevents the cannula from slipping out of the sac, an accident from which recovery is usually impossible and after which the fluid leaks into the subcutaneous tissues from which it is absorbed in a few days.

After the tunica has been completely emptied and the cannula withdrawn the underlying testicle should be critically examined. Very often the reflection of the tunica vaginalis from the epididymis forms a plastic ridge which may be mistaken for epididymitis or other trouble and in any case of doubt it is advisable to repeat the examination in a few days. In the meantime the fluid is microscoped. If still in doubt after a second examination there is much to be said for urging open operation.

After tapping the scrotum is supported in a suspensory bandage. The fluid re-accumulates in a matter of weeks or months and unless some other steps are taken the process has to be repeated.

*Injection*—After tapping a sclerosing solution is injected into the tunica. The method is not generally popular but has its enthusiastic supporters. Ewell, Marquardt and Sargent (1940) recommend quinine hydrochloride and urethane injected into the empty sac at weekly intervals in quantities of 2 c.c. or occasionally 3 or 4 c.c. They find sodium morrhuate more painful and suggest that if it is to be used it should be preceded by an instillation of nupercaine which is re-aspirated after ten minutes. Correa (1938) used sodium salicylate in 5 and 10 per cent solutions and Livermore (1938) packs the tunica vaginalis lightly through a cannula with shoe string tape soaked in sodium morrhuate. This is subsequently withdrawn an inch or two at a time over the next five days or so. This may prove a painful proceeding. A mixture of quinine and urethane appears to be the injection of choice.

If treatment by injection is to be attempted it is essential that the operator be armed with suitable instruments. A fine trocar and cannula should be used with a syringe which will fit snugly into the cannula. Failing this a short needle should be inserted into the cannula. A small disc of rubber will act as a washer and prevent leakage. It is quite unsafe to introduce sclerosing solutions through a needle alone as it is impossible to be certain that the tissues are not being injected. After such an accident orchidectomy may be needed.

The use of iodine and carboic acid originally employed for these injections has now been abandoned.

*Operation*—Three operations are available: (1) orchidectomy, (2) excision of the sac, and (3) eversion of the sac.

ORCHIDECTOMY is seldom necessary unless some serious complication has arisen. When sepsis has supervened or when there is gross damage from attempted injection, orchidectomy has the advantage of a rapid convalescence whereas conservatism in such a case may mean a long wait for a poor reward.

*Excision of the sac*—This is regarded as the operation of choice by some. It is certainly indicated in the small group of cases in which the sac has become hard and thickened. The testicle is delivered completely through an incision in the groin extending on to the upper part of the scrotum. All attachments to the scrotum are cleared and hæmostasis determined with meticulous care. The tunica vaginalis is then opened and the sac dissected away as completely as possible. The many briskly bleeding points are picked up and tied. Transfixion sutures may be needed. Finally the cut edge may need whipping with a running suture to control bleeding which must be done thoroughly. Winkelmann everts the cut edges and unites them behind the epididymis thus combining excision with eversion. Drainage is essential. If a tube in the wound alone does not seem sufficient a dependent drain should be added. Such drains should never be left more than forty-eight hours because of the risk of introducing infection.

Diathermy may be used in the excision to reduce the bleeding but is not really much help as the vessels are mostly too large to be controlled by the diathermy current except by deliberate coagulation and this method increases oedema in the operation area.

*Eversion of the sac*—The classical operation of Jabonlay (or Wyllis Andrews's modification) is the operation of choice in most cases of hydrocele. An incision is made in the groin reaching just on to the scrotum. The tissues are opened up around the cord and a finger passed around the hydrocele which is separated from the scrotum as far as is convenient. By pressure from below the upper end of the swelling is made to present in the wound and the sac is tapped. Delivery is then completed and all attachments to the

scrotum cleared hæmostasis being secured with great care. When the testicle and sac are quite free an opening is made into the tunica vaginalis. In Jaboulay's operation this is carried out freely especially in the upward direction. The sac is then turned inside out and sutured in this position. Wyllys Andrews also stresses the importance of a high incision in the sac but makes this only a few centimetres long. He passes the testicle through this opening and follows it by everting the entire sac in like fashion. The success of either procedure depends upon freeing the parts completely and upon scrupulous hæmostasis. Drainage is essential but must not be continued beyond forty-eight hours for fear of introducing sepsis. The Wyllys Andrews operation is the best to practise as a routine.

**Post operative care.**—The importance of hæmostasis and drainage has been stressed. The scrotum should be kept elevated above the level of the thighs by being rested upon a sling formed by placing a single broad piece of strapping across between the legs. When convalescent a suspensory bandage should be worn. Careful attention to these details should obviate the unhappy conclusion in which the scrotum remains as large after operation as it was before. This is due to hæmorrhage and oedema rather than to the bulk of the everted sac and indicates a technical failure.

Post operative hæmorrhage with the early formation of a hæmatoma is best dealt with radically. An anæsthetic should be given the hæmatoma evacuated and hæmostasis checked.

**Varieties of hydrocele.**—CONGENITAL OR INFANTILE HYDROCELE or indeed vaginal hydrocele in an infant may be treated in the first instance by acupuncture. A needle introduced at a number of points allowing the fluid to escape into the areolar tissues may be enough to dispose of the condition. This failing operation must be undertaken. In general hydrocele in a newly born or young infant may safely be left for several weeks and about 1 in 3 will absorb. In the remainder acupuncture may be tried but eversion of the sac is probably the soundest procedure. It is unwise to delay treatment for more than a few months because of the possibility of atrophy supervening.

**HYDROCELE OF THE CORD** is recognized as a movable but irreducible swelling in the upper part of the scrotum at the external ring or in the inguinal canal. It transilluminates readily. It is best treated by excision which is a simple matter. Hernia should be carefully excluded at the same time.

**BILOCULAR AND INTERSTITIAL** hydroceles may attain a considerable size and may present problems in diagnosis. In an infant a hernia often transilluminates very well but seldom presents any difficulty in reduction. In the adult an irreducible hernia can be distinguished by its failure to transilluminate. Transillumination may also fail with a much thickened hydrocele sac wall. An interstitial hydrocele with a thick wall is thus indistinguishable from an irreducible hernia but such a combination of circumstances is unlikely to be encountered.

Operation is the treatment of choice in these cases in which the sac may sometimes attain a great size notably in the rare abdomino scrotal examples (Prather 1942).

### SPERMATOCELE

Under this heading are included a number of lesions. These are —

- 1 Cysts solitary or few in number arising from the conus vasculosus as retention cysts containing a milky fluid in which spermatozoa are found. These are true spermatoceles.

- 2 Similar cysts containing a clear fluid in which spermatozoa cannot be found. These should not be called spermatoceles, but cysts of the epididymis (Abeshouse 1937)
- 3 Similar clear cysts arising from vestigial remains (Abell 1936)
- 4 Polycystic disease (Abell 1936, McCrea, 1935, Jacapraro, 1937, Abeshouse 1937). In this the greater part of the epididymis is replaced by a polycystic mass

**Diagnosis**—Spermatoceles or epididymal cysts may attain such a size as to resemble a vaginal hydrocele. The resemblance is enhanced by ready transillumination. The differential diagnosis is made by the fact that the testicle can be recognized apart from the cyst and at a lower level. Further, if the cyst is tapped a white fluid either clear or milky but in either case different from hydrocele fluid is obtained. The multiple nature of the cysts is often not apparent before operation is undertaken.

**Treatment**—Fairly large cysts may be tapped with or without subsequent injection just like a hydrocele. If of no great size, the cysts may be left untreated. If of moderate or considerable size, operation is the treatment of choice.

**Operation**—The testicle is exposed and the cysts dissected away as carefully and completely as possible. In extensive polycystic disease, epididymectomy should be performed.

### HÆMATOCELE

**Ætiology**—This important condition may arise as an unexplained sequel to a hydrocele or, more commonly, as a result of accidental or surgical injury to a hydrocele. Alternatively it occurs after injury to the tunica vaginalis by direct violence, with or without an open wound, and in torsion of the testicle.

**Pathology**—The proportion of blood in the fluid varies, but there is a general tendency to the formation of clots and later to the deposit and organization of fibrin around the testicle and within the parietal layer. The fibrin forms successive grey green or brown layers with a dark, contained fluid showing crystals of hæmatoidin and cholesterol.

The testicle atrophies and becomes fibrosed, from pressure. There may eventually be patches of calcification here and there.

**Diagnosis**—There is enlargement of the scrotum on the affected side, with a variable amount of bruising of the surrounding structures and pain. Transillumination fails and tapping produces nothing at all or a blood-stained fluid with imperfect relief. These points serve to distinguish the condition from hydrocele. The diagnosis from new growth depends mainly upon the history. If this is in doubt, an exploratory incision is almost certainly advisable and operation is, in any event, good treatment.

**Treatment**—In all but the mildest cases, early operation is advisable. The clots should be turned out, hæmostasis secured and the operation completed as for hydrocele. Delayed operation is very likely to end as an orchidectomy either from inability to make an accurate diagnosis or from inability to carry out any other helpful procedure.

**Complications**—Sepsis may be introduced very easily or may arise from previous inflammatory disease in the genital tract.

## CHYLOCELE

This rare condition is due to invasion of the lymphatics of the cord by *filaria Bancrofti*. The diagnosis is made by the finding of an apparent hydrocele which does not transilluminate in a patient who usually shows other evidence of infestation. When tapped a milky fluid is found. Excision of the sac is necessary. Romiti (1936) talks of varico-lymphocele and advocates opening the inguinal canal and dissecting the pampiniform plexus and lymphatics away from the other structures of the cord. This mass is then pushed down into the scrotum and approached and dissected away through a second incision.

## TORSION OF THE HYDATID

A not uncommon clinical entity is torsion of the hydatid of Morgagni (Lambert and Smith 1938). This occurs as a sudden attack of pain with localized tenderness and a minimal amount of swelling in the region of the globus major of the epididymis.

**Diagnosis**—The diagnosis from epididymitis is not easy when first seen unless the classical finding of an exquisitely tender body about the size of a pea is present but the sudden onset localized nature of the lesion and the absence of corroborative evidence of inflammatory disease are all suggestive. If seen again after a few days the diagnosis will probably be made on these grounds and the stationary nature of the lesion.

**Treatment**—The hydatid can best be excised if the patient is seen at the very beginning of the attack. If he is not seen for some days it is probably best to leave the condition to settle down by itself. The twisted hydatid will heal in scar tissue and produce much the same end result as if it were cut down upon. The two reasons for operating are therefore (1) to confirm the diagnosis and (2) to shorten the period of invalidism.

## LOOSE BODIES

Fibrinous, fibrous and calcified loose bodies are found in the tunica with reasonable frequency. They have little clinical significance and probably arise either from the organization of exudates or the separation of pedunculated inflammatory outgrowths from the walls of the sac.

## NEOPLASMS (see p. 575)

CHARLES WELLS

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## CHAPTER LIV

### SPERMATIC CORD

#### DEVELOPMENT

**S**HORTLY before full term the testicle pushes through the anterior abdominal wall to take up its position in the scrotum. As it does so, it carries the layers of the abdominal wall forward and each provides a covering for the testicle and for the cord. The structures of the cord are derived from a number of embryonic sources. Thus the testicle derives its blood supply from a high level, the coverings derive their supply locally and the vas is supplied by yet a third vessel arising from the inferior vesical artery, reflecting the primitive fixed point of the Wolffian duct.

#### ANATOMY

The spermatic cord is the pedicle of the testicle and carries all the vessels, nerves and lymphatics together with the vas deferens and a vestige of the processus vaginalis. The cord extends from the internal abdominal ring, where its structures are brought together, to the testicle where they again break up. It lies in an oblique canal, the inguinal canal, and is intermittently subjected to compression by contraction of the internal oblique and transversalis muscles which close the canal when they contract. It is this mechanism which guards against the occurrence of inguinal hernia, to which man is predisposed firstly by the migration of the testicle and secondly by the adoption of the erect posture.

The vas deferens is a firm cord like structure which can be recognized easily upon palpation. It skirts the side wall of the pelvis to reach the internal ring where it passes round the outer side of the deep epigastric artery. It is 15 to 18 in long and about  $\frac{1}{16}$  in in diameter. Its lumen is lined with cylindrical epithelium arranged in longitudinal folds. The wall, capable of strong peristaltic movement, is a powerful tube of unstriped muscle surrounded by a tough sheath of adventitia. Infection may spread along this sheath, but the lumen of the vas is the more usual route. This lumen becomes continuous with that of the epididymis at the globus minor. At this point the diameter of the duct narrows and infection is commonly first recognized here, partly on this account and partly because of the action of gravity.

The arteries are—(1) The spermatic artery which springs from the aorta just below the renal. It supplies a branch to the ureter, enters the spermatic cord and terminates to the inner side of the epididymis in the hilum of the testis which it supplies. It also gives a small branch to the globus major. (2) The artery to the vas. This is a fine branch of the inferior vesical which lies in close contact with the vas, on the surface of which it follows a tortuous course. It is distributed to the epididymis. (3) The cremasteric artery, which comes from the deep epigastric at the internal ring and immediately enters the spermatic cord in the coverings of which it lies. It terminates in the parietal surface of the tunica vaginalis and anastomoses with the epididymal branches of the artery to the vas and with the spermatic artery near its termination.

No free anastomosis between these vessels and those supplying the scrotum is ordinarily recognized, but Neuhof and Mencher (1940) claim that in the repair of hernia the cord can be cut across completely near the internal ring and that atrophy of the testicle follows in only 50 per cent of cases. On the other hand, if in the course of an operation for maldescended testicle, in which the testicle is disturbed from its environment, the spermatic artery is divided atrophy ensues in most cases. The cremasteric artery and artery to the vas may maintain the health of the organ in 10 or 15 per cent of these cases (Mixte, 1924).

The lymphatic vessels of the testicle run in the cord towards the pre aortic lymph nodes below the renal artery. These are the primary glands concerned with the interception of testicular lymphatic drainage. Similarly, sympathetic fibres are distributed to the testicle mainly from the renal and aortic plexuses.

The testicular veins emerge from the hilum of the testis to the inner side of the epididymis and unite in a freely anastomosing plexus, the pampiniform plexus. This plexus becomes less complicated as it is followed up the inguinal canal, towards the upper end of which it forms two trunks which finally unite to end as the spermatic vein. This empties on the right side, obliquely into the vena cava below the renal vein. On the left it opens at a right angle into the left renal vein. There are numerous valves in the plexus and in the spermatic veins, the openings of which are ordinarily guarded by valves.

### VARICOCELE

In varicocele there is enlargement and engorgement of the veins of the left pampiniform plexus. The left testicle is normally a little lower than the right, but in varicocele this difference is exaggerated and the scrotum is distended by the venous mass which may be recognized by its tortuous outline. The testicle may be smaller and softer than the right and may lie horizontally. Its small size is variously attributed to hypoplasia and atrophy, the deficiency being in either case attributed to back pressure.

**Ætiology**—In the anatomical peculiarities of the testicular circulation the essential explanation of the condition is to be found. Normally, these veins are valved but the valves may be deficient here as elsewhere, and a familial tendency to varicocele in particular and varicosity in general may be traced.

In other cases the condition is secondary to intra abdominal pressure or, more particularly, to hypernephroma in which the renal vein becomes invaded with growth, with consequent obstruction to the drainage of the pampiniform plexus.

**Diagnosis**—Some fullness of the pampiniform plexus is normal. The diagnosis of varicocele is therefore a matter of degree. It is most often made in unsuspecting young men presenting themselves for examination for one or other of the fighting Services. In other cases men complain of the low level to which the scrotum hangs, especially in warm weather, or of a dragging pain associated with this peculiarity.

When examined, the left side of the scrotum is seen to be filled with a tortuous mass of veins, and when taken between the finger and thumb these veins are palpable as a rather slippery mass, classically described as feeling like a bag of worms.

Corner and Nitch (1906) and Barney (1910) analysed large series of cases and found the condition bilateral in about 5 per cent and right-sided alone in less than 1 per cent.

**Clinical significance**—In civilian practice very little importance is attached to this condition. Attention is not directed to it gratuitously and the patients who do make complaint are usually ready enough to accept reassurance. The insistence of the Services upon operative treatment is often attributed to a too great regard for tradition or simply to ignorance. The true explanation is (1) that in hot climates the engorgement becomes much increased and (2) that it is bad policy to admit to the Services any man who has a ready made disability to fall back upon when it best suits him.

**Treatment**—1 **CONSERVATIVE**—On the assumption that the condition is little more than an exaggeration of the normal with an added neurosis reassurance and local support with a suspensory bandage may safely be advocated as the treatment of choice in most cases.

2 **OPERATION** is advisable in resistant cases and is obligatory in patients who are to join the Services. The testicle and cord are delivered freely through an inguinal incision and the pampiniform plexus exposed by dissecting away the coverings. The veins are then examined in the upper part of the canal where two or three run alongside one another. At this level the portion to be removed is selected and divided between hæmostatic forceps. The distal end is then followed downwards towards the testicle. In the distal part communicating branches need to be divided carefully. Finally a little above the level of the testicle the remaining vessels are picked up and cut across. The upper and lower cut ends are then securely tied and the ligatures united to one another so as to support the testicle at a higher level than that at which it originally lay.

The objections commonly held against this operation which have the support of Corner Nitch (1906) Barney and many other writers are that atrophy of the testicle and/or hydrocele may be caused. Moro (1938) suggests that the vessels should be dissected and slung to the external oblique with a slip of aponeurosis. The testis is then supported by attachment to the pillars of the ring. Jondres (1934) is satisfied with slinging the testicle by a strip of aponeurosis cut from the external oblique and turned downwards from the external ring to be fixed to the tunica albuginea. He does not remove any of the veins and claims that the support afforded by the aponeurotic sling is sufficient to ease pain and allow congestion to subside.

It must be borne in mind that the spermatic artery lies in close relationship to the veins and is likely to be injured if the operation is done carelessly. It seems not improbable that atrophy when it occurs is attributable to such an accident. Indeed the operation as commonly described is carried out in such a way as to sacrifice the spermatic artery deliberately in the mass division of the pampiniform plexus and subsequent atrophy is no cause for wonder.

Another complication of more than academic interest is hæmorrhage from slipping of the proximal ligature. This is no doubt caused by the customary slipping of the testicle on this ligature. Prompt action is called for if this accident occurs as the resultant bleeding is very severe.

3 **INJECTION** has its advocates and Gray (1936) describes a helpful technique. The injection he says is best made after a hot bath when the veins are fully distended. The patient stands with his buttocks resting against the edge of a table and the varicocele is taken up by the left hand of the operator. Two cubic centimetres of quinine and urethane are injected intravascularly and the scrotum thereafter is supported in a suspensory bandage.

**VOLVULUS**

This is an extremely rare condition in which a loop of the cord itself becomes twisted inside a hermal or hydrocele sac. It is so rare that it can scarcely be considered in a differential diagnosis.

**TORSION**

This is identical with torsion of the testicle which is discussed in Chapter L.

**HYDROCELE OF THE CORD**

The usual type of hydrocele of the cord sometimes known as encysted hydrocele is described in Chapter I II.

Diffuse hydrocele of the cord is less common. It resembles an infiltrating oedema of all the structures of the cord and its true nature remains obscure. It is not often seen but may occur in young people.

Conservative treatment is usually all that is required but operation may be called for occasionally. The affected cord is then exposed and incised through its coverings. The existence of hernia or other significant trouble must be carefully excluded.

**HÆMATOCELE**

This is invariably a traumatic condition which may arise as an independent entity or in association with hæmatocele of the tunica vaginalis. The ætiological factor may be casual such as a knock or a kick in the groin or it may be surgical resulting from injection or operation. If the hæmatoma is of any size whether diffuse or localized it is best to evacuate it early otherwise conservative treatment with support and cold applications will suffice.

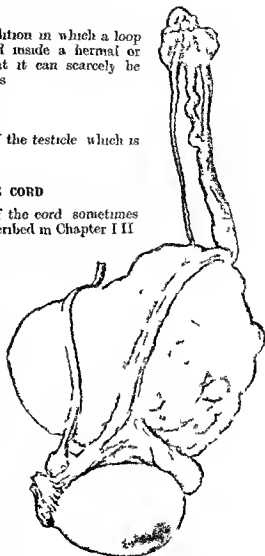


Fig. 293

Sarcoma of the spermatic cord. Removed by operation from a man aged 33.

**NEW GROWTHS**

Although rare these are very varied and a good deal of work has been done in collecting records of these cases (Fig. 295). Thompson (1936) reports twenty-six such tumours seen at the Mayo Clinic. They were simple lipoma 21, fibroma 1, hæmangioma 1, cystadenoma 1, fibrosarcoma 1, myosarcoma 1. Neal and Jolley (1941) report a fibro-myxo-lipoma and submit

the following list which was collected from the literature by Schulte, McDonald and Priestly (1939)

BENIGN		MALIGNANT	
Lipoma	90	Fibrosarcoma	15
Fibroma	34	Leiomyosarcoma	2
Leiomyoma	3	Rhabdomyosarcoma	2
Myoma	4	Sarcoma	39
Dermoid	14	Reticulosarcoma	1
Teratoma	1	Lymphosarcoma	1
Lymphangioma	5	Myxochondrosarcoma	2
Hæmangioma	4	Carcinoma	3
Myxoma	1		—
Myxofibroma (possibly neurogenic)	1		65
Neurofibroma	1		
Cystadenoma	1	Unclassified	6
	159	Other mesodermal tumours	17
		Total tumours	247
Benign tumours approximately			71 per cent
Malignant tumours, approximately			29 ,

It may be concluded that since three-fourths of such tumours are simple, a biopsy should be undertaken before a radical operation is done in any doubtful case. By radical operation, orchidectomy is implied, with pre-operative or post operative radiation, or both. Thompson (*loc cit*) does not believe that the results justify the more radical operation in which an extensive dissection of the pre aortic glands is included.

### VASCULAR DISEASE OF THE CORD

Thrombo angutis obliterans in the spermatic cord is described by a number of writers whose observations have been carefully documented by Mathe (1940) who himself adds a case.

McGavin (1935) reports two cases of spontaneous thrombosis of the pampiniform plexus. He says that in the acute phase this condition resembles epididymo orchitis or torsion, whilst in its later stages it needs to be distinguished from tuberculosis and growth.

### VASOTOMY : VASOSTOMY . VASOLIGATION

The vas deferens may be deliberately obstructed for a variety of reasons. The following are the usual indications —

- 1 For voluntary sterilization in individuals suffering from transmissible disease such as retinitis pigmentosa, insanity, etc.
- 2 For the avoidance of epididymitis as a step in the operation of prostatectomy and in other operations on the bladder and the neck of the bladder.
- 3 In tuberculosis especially when one testicle has become diseased or has been removed, to protect the other from involvement.
- 4 For rejuvenation and/or the relief of prostatism—Steinach's operation. This is based upon the belief that the seminiferous tubules atrophy and that the interstitial cells of Leydig increase with a corresponding increase in internal secretion. The truth of these beliefs has never been demonstrated and the evidence is that they are not founded upon fact.

**Technique**—The cord is grasped between the finger and thumb of the left hand in the upper part of the scrotum and the vas identified. An

incision  $\frac{3}{4}$  in long in the line of the vas is carried through the scrotum and the coverings of the cord. The vas is then grasped with a Kocher's or other toothed forceps (this is important, as it will usually be lost from the grasp of a non-toothed forceps) and drawn out of the wound. It is then cut across and the upper or proximal end sutured in the wound. If the vas is not divided but simply tied and dropped back, its lumen will often open up again by re-anastomosis (as occurs in the intestine when constricted by a single encircling ligature). If the proximal end is allowed to drop back, infection will determine an abscess at the point where it then lies. If it is fixed as a vasostomy this may be avoided.

When the operation is done for voluntary sterilization it is important to warn the patient that he remains fertile for several weeks by virtue of the active sperms already stored in the vesicles. Three months should elapse before sterility is assumed, unless specimens of ejaculate are examined.

Steinach's second operation (Steinach 2), which superseded simple vasoligation, is ligation of the vasa efferentia by passing a silk ligature around the neck between the globus major and corpus testis. This operation rests upon the assumption that by cutting the spermatozoa off from the canal of the epididymis in which they may accumulate the arrest of spermatogenesis is more complete.

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## CHAPTER LV

### THE SCROTUM

#### ANATOMY (after Gray)

**T**HE scrotum is a cutaneous pouch containing the testes and the lower part of the spermatic cords. It normally varies considerably in size, although generally it accommodates itself to the size of the testicles.

In non-descent of the testes it is small and undeveloped. It is divided on its surface into a right and a left portion by a ridge, or *raphé*, which is continued forwards to the undersurface of the penis and backwards along the middle line of the perineum to the anus, the left portion hangs lower than the right. The external appearance varies under different circumstances, thus, under the influence of warmth and in old and debilitated persons, the scrotum is elongated and flaccid, but under the influence of cold and in the young and robust it is short, corrugated, and closely applied to the testes—the result of the action of the dartos muscle.

The skin is very thin and thrown into folds or *rugæ*. It is beset with thinly scattered crisp hairs, and is provided with sebaceous follicles. It is very elastic and capable of great distension, as is seen in cases of large hydroceles. On account of the looseness of the skin and the abundance of subcutaneous tissue, the scrotum may become greatly enlarged in cases of œdema, inflammatory or otherwise.

The dartos tunic consists of a thin layer of non-striped muscle fibres, continuous around the base of the scrotum, with the superficial fascia of the groin and of the perineum. It sends inwards a septum, which connects the *raphé* to the undersurface of the root of the penis, and divides the scrotal pouch into two compartments for the testes. It is closely united to the skin, but is connected with the subjacent parts by delicate areolar tissue, upon which it glides with the greatest facility. The contractile power of the dartos is responsible for the diminution in the size of any wound of the scrotum.

**Arteries**—The scrotum derives its arterial supply from branches of the femoral artery, the perineal artery and the inferior epigastric artery.

The veins follow the course of the corresponding arteries.

The lymphatics drain into the inguinal lymph glands.

The nerves are derived from branches of the lumbar plexus, the perineal nerve and the posterior femoral cutaneous nerve.

#### PHYSIOLOGY

The scrotum of man performs the important function of being thermo-regulatory, and in this connection it has been stated that low temperature of the scrotum is essential for complete spermatogenesis.

#### MALFORMATIONS AND ANOMALIES

These are rare and are usually associated with developmental defects. Thus the scrotum may be partially or completely undeveloped in maldescent

of the testes or more complex deformities may be present as in true or false hermaphroditism and in hypospadias.

### CUTANEOUS DISEASES OF THE SCROTUM

The following are the commonest cutaneous diseases of the scrotum —

**Erythema intertrigo**—This condition is seen most commonly in children and obese adults and is the result of continuous soiling of the parts and clothing by urine or perspiration.

Treatment consists in keeping the parts scrupulously clean and dry and hence a dusting powder is useful. Where the condition is resistant a piece of lint soaked in calamine lotion applied to the scrotum and held in place by a suspensory bandage will generally effect a cure.

**Erythematous eczema**—This may follow neglected erythema intertrigo and is seen most frequently in obese rheumatic or diabetic subjects.

**TREATMENT**—Greasy applications should be avoided. The adoption of the measures suggested in the treatment of erythema intertrigo will generally prove efficacious in addition regulation of diet and general treatment may be indicated.

**Exudative eczema**—Erythema weeping scaldiness and crusting occur and the skin may become oedematous. The eruption may be part of a flexural type of seborrhoeic dermatitis or may arise from a fungus infection—Dhobi's Itch.

**TREATMENT**—In the seborrhoeic type calamine lotion containing 2 per cent sulphur is helpful and where superimposed secondary infection occurs a 2 per cent gentian violet paint may be of use.

**Know-how**—The scrotum is occasionally affected. The condition usually yields to treatment by Whitfield's ointment (acid salicyl gr xx acid benzoic gr xx paraffin molle 1 oz).

**VENEREAL LESIONS**—(see p. 379)

Among other cutaneous affections are *scabies*, *psoriasis*, *lichen planus*.

### ELEPHANTIASIS AND LYMPH SCROTUM (FILARIASIS)

**Ætiology**—Elephantiasis of the scrotum and lymph scrotum are diseases endemic in certain tropical countries and are due to lymphatic obstruction by the *filaria sanguinis hominis* (*filaria Bancrofti* or *wuchereria Bancrofti*). The disease is practically unknown in temperate climates and its geographical distribution is said to extend from 35° N to 25° S in the Eastern and from 25° N to 30° S in the Western Hemisphere. It is especially associated with areas where the atmospheric humidity is high. Manson states that it is indigenous to almost every tropical and subtropical country from Charleston (U.S.A.) and Southern Spain to Brisbane in Australia. It is commonest in India, South China, Samoa and many Pacific Islands where fully 60 per cent of the inhabitants are affected and it is not infrequently seen in South America, West Indies, West and Central Africa.

The parent filariae live in any part of the lymphatic system. The female gives birth to an unending stream of embryos which enter the blood stream through the lymphatics. They are about the ninetieth part of an inch in length and the diameter of a red blood corpuscle so that they readily pass through the capillaries. The further development of the embryos is associated



with the mosquito which acts as an intermediate host, and the infection is probably direct as in malaria. *Filaria* may be present in the body without causing symptoms and Manson suggests that it is the ova prematurely discharged—which are considerably shorter and thicker than the full-grown embryos—which block the lymph channels, causing inflammatory thickening, stenosis and thrombosis and thus producing the conditions of elephantiasis and lymph scrotum.

**Lymph-scrotum**—The scrotum becomes enlarged and lymphatic varices develop on the skin. These varices rupture spontaneously, or when pricked, and discharge large quantities of straw-coloured, milky or sanguineous-looking or rapidly coagulating lymph or chyle. *Microfilaria* are generally present in this fluid.

Treatment is by excising the affected scrotal skin but chyluria or elephantiasis of a lower limb may supervene. If untreated, the condition may pass into a true elephantiasis.

**Elephantiasis of the scrotum** ("scrotum tumour")—As a rule the disease commences with an attack of fever associated with redness swelling and pain in the scrotum. Similar recurrent attacks occur, each attack coinciding with an increase in size and a thickening of the skin of the scrotum most marked towards the lower part, and eventually the scrotum may become enormous (Fig 296). Enclosed in this rind, in a mass of lax, blubbery, dropsical areolar tissue the testes, cords and penis are embedded. The penis is incorporated in the scrotal mass, and generally the prepuce is dragged on and inverted so as to form a long channel leading to the glans penis and opening half-way down or even lower on the face of the tumour (Fig 296). The testes lie towards the back of the tumour fairly low down, being held by the hypertrophied remains of the gubernaculum testis. Hydrocoeles with thickened tunica

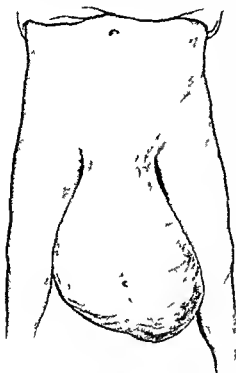


FIG 296

Elephantiasis of the scrotum (scrotum tumour). Note—Penis incorporated in scrotal mass. Urine issues from opening low down on face of tumour.

vaginalis are the rule. The spermatic cords are thickened and elongated, and the arteries and veins are of considerable size. 10, 20 or 40 lb is a common weight for such tumours and cases have been reported where the weight exceeded 200 lb.

**Non-filarial elephantiasis of the scrotum**—This occurs in patients who have never been in the tropics and is probably due to blocking of the lymphatics from chronic inflammation or from operations involving interference with the inguinal lymphatic drainage areas. The condition is rare.

**TREATMENT OF ELEPHANTIASIS**—In established cases excision of a part or the whole of the scrotum is the only form of cure. It is contraindicated in old and enfeebled patients but Connell (1932) states that it is as simple, and

about as free from risk as the radical cure of an uncomplicated inguinal hernia. He reports fifty-six cases with one death and with no recurrence in any case operated on by him.

*Connell's operation*—A circular incision is made right round the neck of the tumour dividing only the skin. An upper flap of skin extending from one external abdominal ring to the other is raised and a lower flap similarly freed. It is only during the formation of these flaps that any considerable hemorrhage is met with, it is controlled by gauze packs while each flap is being cut and thereafter all bleeding points are individually secured. One inch incisions are then made over the upper part of each spermatic cord near the external abdominal ring and also over the root of the penis. A loop of gauze is now passed round each of the three structures thus exposed and isolated at their bases. Behind the isolated segment of penis a closed large clamp is pushed backwards through the scrotal tumour thus dividing it into two halves. Each half is now grasped about 1 in. distally to the pubes and perineum by a powerful clamp the cords and penis being carefully avoided. The penis, cords and testicles are now fully exposed by long vertical incisions and dissected free, the cords being completely denuded of their fibrous coverings till the blood vessels are clearly seen (this step establishes a new lymph pathway from what will be the new scrotum to the lumbar glands). The preputial opening is surrounded by an incision so that as much foreskin as possible is saved—it is used subsequently as a covering for the penis. At this stage hydrocœles or hernia may be found—they must be dealt with by the most rapid method. Hydrocœles by eversion of the sac and hernia in a temporary manner by simple ligation of the sac without opening the inguinal canal. The amputation of the elephantoid scrotum is now completed by division of the tissues proximal to the two large clamps, bleeding vessels being secured by forceps as they appear. At this stage a direct lymph pathway via the internal pudic and prostatic lymphatics to the internal iliac glands is opened up by laying bare the perineal muscles and dividing the line of fusion between Colles's fascia and the two layers of the triangular ligament. Hematoma formation is very liable to occur and thus all bleeding points must be sought carefully and ligatured. Finally the upper and lower skin flaps are united along a median vertical line in such a way as to form a new scrotum into which the cords and testicles are tucked. Drainage is provided by a small rubber tube inserted through the lower end of the suture line and retained for forty-eight hours. The penis is covered by pulling back over it like the finger of a glove the preserved inner lining of the prepuce the cut edges of which are fixed by a few points of suture to the edge of the upper skin flap. If sufficient healthy foreskin cannot be conserved to act as a penile covering the penis should be left raw and at a later date covered by a skin flap. Thiersch grafting is unsuitable. Sepsis is likely to develop in some degree in the wound and thus an antiseptic dressing renewed at regular intervals is advised.

#### NEW GROWTHS OF THE SCROTUM

**Benign growths**—**SERACEOUS CYSTS** of small size white in appearance and somewhat elevated occasionally pedunculated are frequently found in the skin of the scrotum. Generally speaking they are unimportant and do not give rise to trouble (Fig. 297).

**DERMOID CYSTS** have been met with in the raphe.

**ANGIOMA LIPOMA FIBROMA AND PAPILLOMA** may occur but they are

The treatment of all these simple tumours is by excision where this appears necessary

**Malignant growths—EPITHELIOMA—*Ætiology***—This is a common condition which frequently follows prolonged irritation by such substances as coal tar soot or paraffin and thus is seen mainly among chimney sweeps tar and paraffin workers (shale oil workers and mule spinners in cotton factories). The condition at one time common in each of these occupations has led to the terms chimney sweeps cancer mule spinners cancer and 'paraffin workers cancer' being applied to it. As the result of modern factory regulations it is now uncommon. Constant irritation of the corrugated scrotal skin, caused by friction against dirt impregnated clothes and personal uncleanness may be contributory factors



FIG 297  
Sebaceous cysts of scrotum



FIG 298  
Epithelioma of the scrotum  
(Prof C F W Illingworth's case)

**Pathology**—The disease usually commences as a small dry scaly eczema tous like area which eventually ulcerates and assumes the typical characters of a malignant ulcer (Fig 298). Sometimes the growth originates in a pre existing wart or papilloma. As a rule the progress of the ulcer is slow. Sepsis in some degree is usually present.

**Treatment**—Owing to the laxity of the skin and the mobility of the parts most lesions of the scrotal skin are very suitable for excision and thus applies equally to the more advanced cases with deep infiltration and complicating sepsis. Treatment by radiation is referred to elsewhere.

The treatment of the *inguinal glands* is often a matter requiring considerable judgment owing to their late involvement and the possibility of their enlargement being due to sepsis. Further enlargement of the inguinal glands may be quite unassociated with the scrotal lesion. They are palpable in a large percentage of healthy persons. When the scrotal lesion is small or superficial and when the glands are not palpable, a watching policy is justifiable. When

the epithelioma is large and infected and the glands enlarged, an interval of a few weeks should elapse before bloc dissection is decided on in order that any septic lymphadenitis should have a chance of subsiding. Removal of the glands at the same time as the tumour is inadvisable in view of latent sepsis. The operation is described in the chapter on epithelioma of the penis.

Treatment of the glands by radiation is effective in certain cases but the combination of radiation and surgery is to be avoided.

SARCOMA—This is a rare condition. The treatment is similar to that advocated for other forms of malignant growth.

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## CHAPTER LVI

### THE PENIS

#### ANATOMY (after Gray)

THE penis is composed of three cylindrical masses of cavernous erectile tissue bound together by fibrous tissue and covered with skin. Two of the masses are placed side by side and are known as the corpora cavernosa; the third, median in position and beneath the other two, is traversed by the cavernous part of the urethra and is termed the corpus spongiosum (corpus cavernosum urethræ).

**The corpora cavernosa**—These form the greater part of the substance of the penis. Throughout the anterior three-fourths of their extent they lie in apposition with one another, separated only by the septum of the penis; behind they diverge in the form of two tapering processes termed the crura, which are firmly connected to the rami of the pubic arch. Anteriorly each corpus cavernosum ends abruptly in a rounded extremity, a short distance from the point of the penis. They are surrounded by a strong fibrous envelope consisting of superficial and deep fibres—the tunica albuginea. The superficial fibres are longitudinal and form a tube enclosing both corpora; the deep fibres are arranged circularly round each corpus and form by their junction in the median plane the septum of the penis. This septum is thick and complete behind but is imperfect in front, where it consists of a series of vertical bands arranged like the teeth of a comb; it is therefore named the septum pectiniforme.

**The corpus spongiosum**—This lies in the middle line on the undersurface of the penis in the groove between the corpora cavernosa. Posteriorly it expands into a rounded mass, the bulb, and anteriorly it forms a cap, the glans penis, which envelops the end of the corpora cavernosa. It is attached to the undersurface of the triangular ligament and covered by the bulbos cavernosus muscle. The urethra enters the upper surface of the bulbous portion about half an inch from its posterior extremity and passes forwards in its substance, piercing it at the conical extremity of the glans penis.

For descriptive purposes it is convenient to divide the penis into three regions—the root, the body, and the extremity.

**The root of the penis** is triradiate in form, consisting of the diverging crura and the median urethral bulb. Each crus is covered by the ischio cavernosus muscle, while the bulb is surrounded by the bulbos cavernosus. The root of the penis lies in the perineum between the inferior fascia of the urogenital diaphragm and the fascia of Colles. In addition to being attached to the fasciæ and the pubic rami, it is bound to the front of the symphysis pubis by the fundiform and suspensory ligaments. The fundiform ligament springs from the front of the sheath of the rectus abdominis and the linea alba; it splits into two fasciæ which pass one on each side of the penis and unite below with the septum of the scrotum. The suspensory ligament is triangular in shape; it is attached above to the symphysis pubis; below it blends with the fibrous envelope of the corpora cavernosa.

**The body of the penis** extends from the root to the anterior end of the

**corpora cavernosa** In the body the corpora cavernosa are intimately bound to one another a shallow groove which marks their junction on the upper surface lodges the deep dorsal vein of the penis while a deeper and wider groove between them on the undersurface contains the corpus spongiosum The body is ensheathed by fascia which is continuous above with the fascia of Scarpa and below with the dartos tunic of the scrotum and the fascia of Colles

The extremity is formed by the glans penis the expanded anterior end of the corpus spongiosum The glans penis is somewhat conical in shape and its concave base covers and is attached to the ends of the corpora cavernosa The projecting margin of its base is named the corona glandis behind which is a constriction known as the neck of the glans (retro glandular sulcus) The terminal part of the urethra runs through the glans penis and ends in a vertical slit on its apex

The skin covering the penis is thin elastic free from fat and hairs and remarkable for the looseness of its connection with the fibrous envelope of the organ At the neck of the glans penis it is folded upon itself to form the prepuce or foreskin which overlaps the glans for a variable distance The internal layer of the prepuce is confluent along the line of the neck with the thin skin which covers and adheres firmly to the glans and is continuous with the mucous membrane of the urethra at the external urethral orifice On the undersurface of the glans penis a small median fold passes from the deep surface of the prepuce to a point on the glans immediately behind the external urethral orifice this median fold is named the frenulum of the prepuce The prepuce is separated from the glans penis by a potential sac—the preputial sac On the corona and neck of the glans there are numerous small preputial glands which secrete a sebaceous material—smegma

The blood supply of the penis is derived from branches of the internal pudendal artery—the arteries of the bulb the deep arteries of the penis supplying the crura and the dorsal arteries The veins from the corpora cavernosa pass to the dorsal vein and the prostatic plexus Those from the corpus spongiosum pass to the dorsal veins and the veins of the bulb

The lymphatics drain to the inner set of inguinal glands on both sides

**Nerves**—The sensory nerve supply of the skin of the penis is derived from the second third and fourth sacral nerves through the pudendal nerve and pelvic plexuses The musculature and rich vascular meshwork of the organ are supplied by parasympathetic and sympathetic fibres from the hypogastric plexus

### CONGENITAL MALFORMATIONS

Congenital malformations of the penis apart from those of the urethra and prepuce are rare

In the embryo the genital tubercle develops as an eminence on the lower part of the front of the embryo and below it two others—the genital swellings—soon appear The genital tubercle enlarges to form the penis and the genital swellings become fused to form the scrotum The urethra is formed by fusion of the margins on the undersurface of the genital tubercle Congenital defects are the result of abnormal or defective development of the constituent parts It is thus possible to understand how malformations *e.g.* hypospadias epispadias rudimentary penis reduplication or absence of the penis may occur

Rudimentary development of the penis—This is not an uncommon type of malformation and is usually associated with endocrine disturbances The

penis may be so small as to be hidden in the redundant tissues of the pubes and scrotum. Where such a condition is associated with a bifid scrotum and undescended testes sex may be difficult to determine, such cases are often regarded as examples of hermaphroditism. In infancy it may be impossible to determine the sex but in most cases the true sex manifests itself at puberty.

**Reduplication**—Cochrane and Saunders (1942) in a review of the literature state that reduplication has been found chiefly in cases suffering from epispadias and ectopia vesicæ and that it seems to be a mesodermal disturbance related to these conditions.

In the case illustrated (Fig. 299) the incontinent bladder emptied through an opening admitting the finger situated between and at the base of the penes on their undersurface.



FIG. 299

Reduplication of the penis. Almost complete absence of the urethra which opens at the base of the penes and is marked by a catheter. (Mr. Arthur Jacobs' case.)

**Absence of the penis**—This malformation is exceedingly rare, and McCrea (1942) states that only eleven cases have been reported. It is said to be due to the failure of development of the genital tubercle, the urethra opening on the perineum. A dwarf penis is generally found concealed beneath the skin of the scrotum or perineum. A congenital urethrorectal fistula sometimes is said to co-exist.

**Adherent penis**—This is usually associated with scrotal hypospadias or it may occur alone when the whole undersurface of the penis may be fixed to the scrotum by web.

**Torsion of the penis**—This is a very rare abnormality and when present is usually associated with other developmental abnormalities of the organ.

**Phimosis**—This term denotes a congenital or acquired narrowing of the opening of the prepuce and is often associated with an unduly long foreskin which is sometimes adherent to the glans penis. The orifice of the prepuce, especially in infants, may be so small as to cause retention of secretions, with

resulting irritation and balanitis and interference with micturition with subsequent back pressure on the bladder ureters and kidneys. In children phimosis has been blamed for frequency of micturition and nocturnal enuresis but many authorities question the association with this condition. The inevitable straining to micturate may result in umbilical and inguinal hernie and even prolapse of the rectum. The relationship between phimosis and venereal sores is well recognized and the retention of secretions e.g. smegma may have some influence on the development of epithelioma and papilloma. PARAPHIMOSIS is not an uncommon complication.

**TREATMENT**—Where the foreskin is unduly long and where the orifice is tight or narrow treatment by dilatation and freeing of adhesions may be adequate in children. In the majority of cases however operation by circumcision is indicated.

**Dilatation** is carried out by stretching the orifice by forceps followed by gradual retraction of the prepuce. When adhesions are present they are best separated by blunt dissection using the closed points of sinus forceps for this purpose. Stripping by gauze is inadvisable as injury to the delicate epithelium of the glans may result.

**Dorsal incision of the prepuce**—When on account of adhesion adequate retraction of the prepuce cannot be carried out it is usually possible to insert closed sinus forceps between the prepuce and glans on the dorsal aspect care being taken that the forceps do not enter the urethra. Following this the prepuce can be slit by scissors. This procedure will facilitate freeing of the prepuce from the glans. Thereafter all smegma is removed and the parts cleaned by gentle mopping with saline lotion. In some cases this is all that is required but completion of the operation by circumcision—in the absence of any contraindications e.g. acute balanitis—is usually carried out.

**Circumcision**—Although the operation is regarded as a minor one it must be neatly and accurately performed. Haemorrhage sepsis and a resulting stenosis worse than the original condition are complications which must be avoided. General anaesthesia is advisable in the majority of cases but the operation can be performed under local anaesthesia where deemed advisable. In a clean case bathing of the parts with soap and water and boracic or saline lotion is all that is required in the way of preparation. Complete exposure of the glans is advisable before one proceeds to remove any tissue. Behind the corona retained secretion and epithelial debris must be removed gently. In infants up to four weeks old anaesthesia is sometimes dispensed with the child being placed on a large pillow on the lap of a nurse seated on a low chair the legs held firmly immediately above the ankles and raised in a lithotomy position and movement of body and arms prevented by their being anchored under the elbows of the nurse. The surgeon should be seated facing the perineum. Toilet of the parts as above described is now performed. It is important to estimate the proper amount of skin to remove. Straight dressing forceps sinus forceps or a light clamp is then applied obliquely to the foreskin immediately distal to the corona and parallel to it the glans slipping back as the forceps close. With a sharp knife or scissors the prepuce is cut off immediately distal to the forceps. This incision results only in the skin being removed the mucous tube remaining behind closely covering the glans. This mucosa may be slit and turned back but it is usual to remove most of it in two halves leaving a narrow collar round the corona. A small artery in the frenum generally requires ligature as well as several small vessels on the dorsum. Failure to ligature these vessels has proved fatal. Four to six sutures approximate the mucous membrane to the skin and for this purpose a



fine round bodied needle and fine catgut are most suitable Finally a gauze dressing smeared with vaseline is tied in position leaving the meatus exposed

The important points in this simple operation are —

- 1 Excessive tissue should not be left about the frenum or a persistent lump may form there
- 2 Sufficient prepuce must be left to cover the sensitive papillæ of the corona
- 3 Unless care is exercised too much skin may be removed so denuding the body of the penis
- 4 Hæmostasis must be adequate

The operation of circumcision is seen in its simplest and commonest form in the Jewish religious rite in the performance of which a shield or clamp is

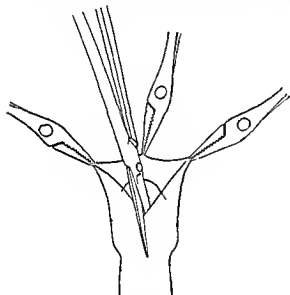


FIG. 300

Circumcision. The prepuce being slit dorsally

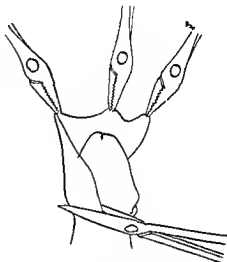


FIG. 301

Circumcision. One half of the prepuce has been cut and the scissors are commencing the cutting of the other half

applied to the prepuce distal to the glans and that part removed by a knife. This leaves the glans still covered by the lining mucosa which is now torn backwards from the meatus to the corona by a sharp pointed finger nail and the flaps so formed are folded back over the cut edge of the prepuce. Bleeding which would seem to be minimal after this procedure is also inhibited by the application of a moderately tight dressing. The results generally are satisfactory and complications such as hæmorrhage and sepsis appear to be rare. The rite is performed on the eighth day.

The operation as above described for an infant is as a rule equally suitable for an adult. In cases where the prepuce is not long but where the orifice is narrow the following operation may be performed.

The prepuce should be retracted so far as possible the orifice being rendered tense. Three pairs of pressure forceps are now applied to the edge of the prepuce two being placed symmetrically at a short distance from either side of the median line dorsally and the third in the middle line ventrally. These are raised and the prepuce is separated from the glans by sinus forceps or a

immediately proximal to the constricting band of the prepuce the thumbs meantime being used to reduce the oedematous area and to press the glans inwards (Fig 303). In this way the prepuce and constricting band are drawn over the glans penis and the parts returned to normal but oedema will persist for some hours. If this manipulation fails then a longitudinal incision should be made on the dorsum of the penis through the oedematous folds and constricting bands. Secondary small incisions may be made in the oedematous areas but are usually unnecessary. A vaseline gauze dressing is then applied. To prevent recurrence the operation of circumcision should be performed when the oedema and congestion have subsided.

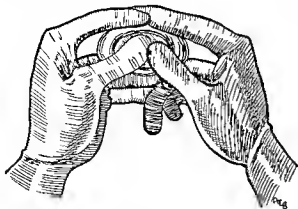


FIG 303

Paraphimosis The method of reduction

### INJURIES OF THE PENIS

**Wounds and contusion**—The missiles employed in modern warfare are the most common cause of wounds but missed wounds whether caused by accident or malice are not uncommon. The treatment of these wounds is similar to that for a wound elsewhere on the body but healing is rapid on account of the generous blood supply. If the wound involves a partial section of the penis every effort should be made to control hæmorrhage and to suture the fibrous sheath of the corpora accurately. Where the urethra is involved diversion of the urine by suprapubic cystostomy or a tied in catheter may be necessary. This condition is discussed under injuries of the urethra. The functional result ultimately should be fairly satisfactory but during convalescence erection must be prevented or sutures tend to be torn out. To prevent this the patient should be kept under the influence of morphia or bromides. A rubber bag filled with crushed ice and applied locally is said to be effective.

Tears of the frenum during coitus are not uncommon and may cause considerable hæmorrhage. Ligation of the bleeding point and repair by a suitably placed fine catgut stitch are required.

**Strangulation**—Usually this is the result of constriction of the organ at any point by such materials as string hair or metal rings. Where a hair is the causative agent this may become so deeply buried in the tissues as to be hardly detectable especially if it be applied around the retroglandular sulcus. Whatever the causative agent if the constriction is not relieved ulceration and swelling associated with considerable pain and difficulty in micturition or even retention of urine may occur. A general anæsthetic may be necessary to remove the constricting band. Gangrene of the part of the organ distal to the constriction is rare.

**Rupture**—This occurs only when the penis is erect and the organ forced downwards between the thighs. When rupture takes place there is a sudden severe pain at the point of rupture followed by deturgescence. In a short time swelling occurs from extravasation of blood, and this gradually increases

until an enormous size may be attained. Treatment consists in elevation of the penis and the application of cold compresses or an ice bag. The final result may be impairment of erection, the proximal segment functioning normally and the distal segment remaining flaccid or becoming erect later. In order to avoid this it has been advised that the fracture should be treated by incision, clearing out of the clots and careful suture. The treatment will depend on the severity of the lesion.

**SECONDARY INDURATIVE CAVERNOSITIS** may occur as a late sequel at the site of injury and indeed any severe contusion, wound or rupture of the organ may act as a predisposing cause to this condition or to its primary variety.

**Dislocation**—This is a rare injury and consists in the body of the penis being forced from its outer sheath and displaced beneath the skin of the scrotum or thigh. Open operation is usually necessary to rectify the displacement.

**Hæmatoma**—This is commonly seen following injuries about the pelvis and is due to extravasation of blood. The extravasation gradually becomes absorbed and no special treatment is required.

### HERPES PREPUTIALIS

This is found commonly on the glans and prepuce but it is not often seen in the vesicular phase as early rupture of the vesicles usually occurs. The resulting erosions are superficial, raw, red and angry looking and frequently show a well marked polycyclic edge which is characteristic of the affection. The pain and tenderness which are marked features help to differentiate this from specific lesions.

The parts should be cleansed thrice daily with normal saline followed by the application of a simple dusting powder.

### ŒDEMA OF THE PENIS

Acute œdema of the penis may follow sepsis, extravasation of urine, venereal disease and constriction by rings or other agents. It occurs occasionally following prostatectomy by the Harris or Millin methods but subsides rapidly; it is thought to be due to interference with the blood supply. In some cases no cause can be demonstrated.

Chronic œdema may follow lymphatic obstruction caused by old standing inflammation of the inguinal glands and by elephantiasis (filarial or non-filarial).

The acute variety resolves rapidly on removal of the cause. The chronic variety may necessitate removal of the affected skin followed by skin grafting.

### PRIAPISM

The term priapism denotes a state of continuous erection of the penis unassociated with erotic sensation or ejaculation and unrelieved by coitus.

The condition is uncommon. Patients suffering from spinal cord lesions appear to be especially prone to priapism but 25 per cent of all cases are said to occur in leukaemia. Thrombosis may be responsible in the presence of gross injury, new growth, inflammation or leukaemia but otherwise it does not occur and incision reveals generally only a syrupy, blackish blood. Pain is a marked feature.

Treatment is on the whole unsatisfactory but Riches (1930) reports a successful result following heat applied by diathermy current. The condition may gradually subside following rest in bed and general treatment. The effect of hydrotherapy and radiotherapy is of doubtful value. Surgical measures

such as incision into or aspiration of the cavernous spaces may relieve the condition but may result in permanent interference with function

CHRONIC INTERMITTENT PRIAPISM is characterized by repeated and sometimes prolonged and painful nocturnal erections unassociated with sexual desire. The condition may recur over a period of years cause insomnia and affect the general health

The etiology is uncertain but the condition may be associated with some lesion of the posterior urethra prostate seminal vesicles or central nervous system

Treatment should be directed to the removal of any local lesion. Bromide and chloral hydrate should be prescribed and sexual excitement avoided. Local cold sponging is sometimes efficacious

### FIBROUS CAVERNOSITIS

**Ætiology.**—Two main types of cavernositis occur—one primary or idiopathic and the other secondary to local damage or disease. This secondary type is dealt with under the headings of its various causes—Trauma Inflammation and Venereal Diseases

The primary variety is referred to as *plastic induration* or *indurative cavernositis* and so far its etiology is unknown. It tends to occur in patients between the ages of 40 and 70 and according to some observers in individuals of a certain diathesis who may also suffer from the comparable Dupuytren's contraction. Gout and diabetes have also been put forward as possible causes but the evidence for this is very meagre. Trauma is said to be a frequent determining cause in the presence of a constitutional disposition. Old age does not appear to be a factor of any real significance

**Pathology.**—The condition is characterized by the appearance of fibrous plaques in the tunica albuginea and pectinate septum. They are usually found on the dorsal surface near the root of the penis less often in the shaft. The plaques are formed of firm fibrous tissue of cicatricial type and usually of cartilaginous consistence in some cases they become calcified (Fig 304). Normally the plaques are in the form of plates but sometimes they form as nodes or strings which spread laterally. Histological examination of the plaques shows no inflammatory cells or changes (Maresch and Chiari 1931)

For further information see p 623

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FIG 304

Fibrous Cavernositis Calcified on occurring in a saddle-shaped dorsal plaque (the bones shown on each side of the glans penis are the terminal phalanges of the assistant's fingers steadying the penis) (Mr W. Larrington's case)

when the papillomata are of the broad, flat-topped variety X rays or radium may be used

### MALIGNANT GROWTHS

Epithelioma of the glans penis is the most common form of malignant lesion, sarcoma and endothelioma may occur but are rare

**Epithelioma—Ætiology**—It is stated that epithelioma of the glans penis and prepuce comprises from 1 to 3 per cent of all carcinomata (McCrea 1940) It usually develops after the age of 45 Chronic irritation resulting from phimosis is a predisposing cause and indeed the disease is almost unknown in the circumcised (Wolbarst 1932) Reference has already been made to cancer occurring in pre-existing warts

**Pathology**—The lesion usually arises on the dorsum of the glans or on a corresponding site on the prepuce or on both Occasionally it originates in the region of the urethral meatus In its early form it may appear as an eroded papule or as a slight thickening of the epithelium or it may have the appearance of a simple wart of sessile type Eventually, when infection is superadded the lesion ulcerates, with a resulting purulent discharge (Fig 308) When the prepuce is long and difficult to retract the condition may exist for a considerable time without being detected the true nature of the lesion being discovered only when the patient seeks advice on account of a discharge The absence of pain is an outstanding feature of the disease



FIG 308

Epithelioma of the penis A large epithelioma which has ulcerated through the prepuce (See Figs 309 and 310)

If untreated, massive ulceration of the parts may occur Invasion of the corpora cavernosa occurs late, and as the corpus spongiosum is rarely involved interference with micturition is uncommon

Lymphatic extension to the inguinal glands is usually a late feature early gland enlargement generally being the result of associated infection (Cope, 1932, McCrea 1940) At a late stage the glands may break down and ulcerate through the skin Distant metastases are rare

**SYMPTOMS AND DIAGNOSIS**—Growth is slow and painless, and the only complaint usually is of a purulent and sometimes blood stained and fetid discharge The end of the penis is often enlarged and only after retraction of the prepuce is a warty bleeding mass revealed Where the urethra is involved micturition may occasionally be difficult and painful but retention is rare\* (Cope 1932) Painful erections may occur At times the lesion has to be differentiated from a primary chancre, especially in the middle aged In some cases it is possible to palpate the ulcer or tumour through the prepuce, in others diagnosis is only evident after the prepuce has been slit Where the diagnosis is uncertain biopsy should always be carried out

**TREATMENT**—Radiation therapy or partial or complete amputation of the penis may be required the choice depending on the extent and character of the growth

*Radiation therapy*—For the early type of lesion this would seem to be the method of choice (see p 614)

*Partial amputation of the penis*—This operation suffices in the majority of cases where the tunica albuginea has not been penetrated (Figs 309 and 310)



FIG 309

Epithelioma of the penis Part removed at operation



FIG 310

Epithelioma of the penis Section through the centre of the amputated penis (shown in Fig 309) which illustrates the resistance of the tunica albuginea to the growth Penis before operation shown in Fig 308 Histological examination of inguinal glands excised 10 weeks later showed no evidence of any secondary deposits

and the disease is limited to the distal half of the shaft but the organ must be of sufficient length to leave a stump clear of the scrotum

The amputation may be performed by a flap or by a circular or an elliptical incision The flap method is the simplest and is that generally used

Whatever method is adopted a tourniquet should be tied round the base of the penis For this purpose a catheter or thin rubber tube can be used

### 1 THE FLAP AMPUTATION

Either a long dorsal or ventral flap may be used but the latter is recommended (Fig 311 A) The width of the ventral flap should be half the circum

### 3 THE ELLIPTICAL AMPUTATION

This method presents no advantage over the other methods. It is performed similarly but the circular incision of the skin is made obliquely downwards and forwards.

#### COMPLICATIONS

Hæmorrhage with hæmatoma formation is liable to occur under the skin flaps. Sepsis is a likely sequel and thus hæmatoma formation must be prevented or if that is impossible the hæmatoma must be evacuated immediately it is observed.

Stenosis of the urethral meatus is a common complication which may be avoided by careful and neat suturing of the urethra to the skin and the avoidance of sepsis. If a retained catheter is used it must be a loose fit in the urethra especially at the orifice as any pressure at that point will favour sepsis. To prevent stricture formation it is often wise to dilate the orifice periodically for a few months following the operation by the use of well lubricated bougies inserted with great gentleness.

*Total amputation of the penis*—This operation is necessary where the malignant growth has spread through the tunica albuginea and involved the cavernous spaces or where spread of the growth proximally has left the shaft too short to permit of partial amputation.

The procedure is as follows. The ulcerated area having been thoroughly cleansed is covered by an antiseptic dressing retained in place by a bandage. The patient having been placed in the lithotomy position and a metal bougie passed along the urethra the base of the penis is encircled by an incision which is continued backwards in the middle line dividing the scrotum along the whole length of the raphe and the incision continued to 1 in. in front of the anus. The bulb is exposed in the perineal part of the wound and the urethra freed to the triangular ligament. The bougie is then removed and the urethra divided about  $1\frac{1}{2}$  in. in front of the triangular ligament (Fig. 312 (1)). The upper part of the incision is deepened the suspensory ligament cut and the dorsal vessels divided between clamps and ligated (Fig. 312 (2)). The crura are exposed and detached from the pubic ramus and ischium by a raspatory and bleeding points secured (Fig. 312 (3)). The cut end of the urethra should be split for  $\frac{1}{2}$  in. antero posteriorly or laterally (to diminish the tendency to stenosis) and sutured to the skin in the posterior part of the wound which is then closed by silkworm sutures. Drainage should be provided by a small tube inserted a short distance in front of the urethra (Fig. 312 (4)).

Where it has been decided to include in this operation complete excision of the inguinal glands this should be done before the patient is placed in the lithotomy position. The skin incision should follow the fold of the groin from one anterior superior spine to the other dividing in the mid line to surround the base of the penis. Commencing laterally and working towards the penis *bloc* dissection of the glands is carried out. Two or three deep glands lying under the fascia lata on the medial aspect of the femoral vein and one gland lying within the femoral ring must be included in the dissection. Thereafter the patient is placed in the lithotomy position and the incision surrounding the base of the penis is continued backwards and the operation performed as above described. Drainage should be established through the outer ends of the groin incisions.

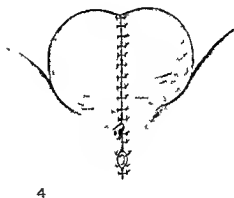
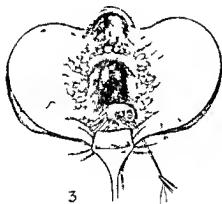
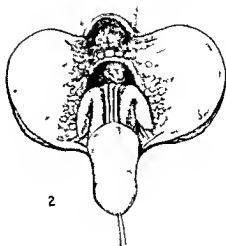
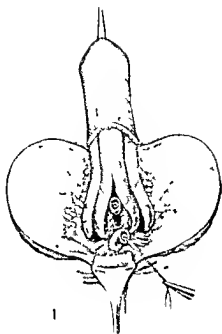


FIG 312  
Amputation of the penis  
613



**Emasculatlon**—In certain cases removal of the testicles and scrotum at the same time as the amputation operation may be advisable on the grounds that the growth has spread to the scrotum or that recurrence there is likely. The situation of the urethra behind the scrotum tends to cause soiling of the scrotal skin with resulting irritation and ulceration, and this makes a further argument for emasculatlon as also that retention of the testes with their secretions is not advisable in the absence of the penis.



FIG 313  
Epithelioma of penis  
(proved by biopsy)  
in a patient aged 63  
(See Fig 315)

The addition of emasculatlon to the operation for radical amputation of the penis adds little to the severity or to the time taken in its performance. After encircling the penis the incision divides one limb going to each side of the scrotum which is encircled on to form skin flaps sufficient in size to cover the raw area. The spermatic cords should be divided at the level of the external inguinal rings, and they are then removed together with the testicles and scrotum. The operation thereafter is similar to the total amputation already described.

**The inguinal glands**—Early enlargement is usual, but this enlargement is more likely to be due to the sepsis accompanying the malignant ulcerative process than to invasion by secondary deposits. Gland metastases are

generally a late feature.

It has been the custom of many surgeons to excise the inguinal glands at the same time as the amputation of the penis. On theoretical grounds this is sound surgery but it should be borne in mind that if the glands are dealt with at the time of amputation severe sepsis not infrequently occurs. In the majority of cases extirpation of the glands by *bloc* dissection should be carried out at a later date. Where the glands have already broken down and are fluctuant sepsis is inevitable but even in these cases an interval between amputation and gland excision may prevent extensive sloughing in the amputation wound.

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**Selection of cases for radium treatment**—It can be stated with confidence that in the present state of our knowledge early cases should in preference be treated by radiation and late cases by surgical methods (Figs 313 to 320). Attention is drawn to this as it is evidence of progress and contrary to the usual principles of selection of treatment in other sites—where the tendency is still to relegate to radiological methods the late extensive inoperable or otherwise unpromising cases. Cancer of the penis is a skin cancer, it is as sensitive or responsive to radiation as other malignant cutaneous lesions. Difficulties there are from the additional factor of infection and the anatomical site and configuration of the lesion. Nevertheless in lesions of reasonable extent radiation offers good chances of total regression of the lesion for many



FIG 314  
Epithelioma of the penis (proved by biopsy)

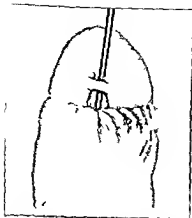


FIG 315

The appearance six and a half years after 3024 mgm hours of interstitial radium. The patient is still alive and well fourteen years after treatment. (Sir Stanford Cade's and Mr Winsbury White's case)

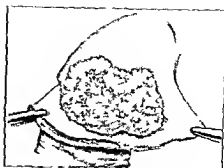


FIG 316

Papillary carcinoma of the penis

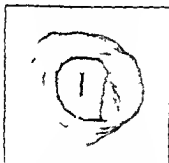


FIG 317

The appearance before opening the preputial sac

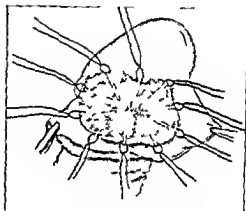


FIG 318

The radium needles in position



FIG 319

The condition three years after 998 mgm hours of interstitial radium. (Sir Stanford Cade's and Mr Winsbury White's case)

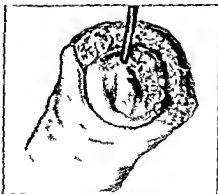


FIG 320

Epithelioma of the penis which disappeared completely after 2016 mgm hours of interstitial radium. (Sir Stanford Cade's and Mr Winsbury White's case)

years. There is no need to point out the mutilation of surgical treatment and this should be reserved for cases unsuitable for radiation. These cases include (1) the extensive lesion involving the entire circumference of the corona and glans and spreading to the body of the penis (2) infiltrating lesions involving the urethra (3) involvement of the corpora cavernosa or of the corpus spongiosum (4) lesions in the very old or the diabetic who stand radiation treatment badly. The macroscopical variety of the lesion is of greater importance than the histological type, the latter although indicating the degree of malignancy is not a practical index of radiosensitivity as even the most keratinizing type with numerous cell nests has been shown to respond favourably. Of the various macroscopical types the papillary or warty neoplasm is the most radiosensitive, the ulcerative lesion less so especially when associated with old standing leucoplakia, the nodular or infiltrating type is the least suitable for radiation. In this type there may be a deep seated extensive tumour with but little surface ulceration. The liability to radium necrosis both in the penis itself and in the inguinal regions is greater than in other situations such as the face chiefly from associated sepsis but also because the skin is moist and thin. The choice between radiation and surgery depends therefore on the extent and the type of lesion—the earlier the case and the smaller the extent of the lesion the more suitable it is for radiotherapy which is the treatment of choice.

*Methods of radiation of the primary lesion*—The radiation treatment of the primary lesion is generally undertaken with radium. In very small and superficial lesions low voltage X rays (60 to 80 k V) has given good results such lesions however must be superficial as the penetration of the rays is negligible. Radium therapy can be given by the interstitial or surface methods.

*Surface irradiation*—The applicator is a cylinder made of a non metallic substance such as sorbo rubber, cork, piano felt or columbia paste. The cylinder wall is 1 cm thick and about 5 cm in external diameter. Radium containers, needles or tubes are placed on the outside of the cylinder arranged in rows spaced equidistally. The quantity of radium required varies with the area to be treated an average of 30 mg is used. The period of irradiation is 240 hours preferably given intermittently twelve hours a day or continuously with short periods of rest. A total of 5 000r to 6 000r is aimed at. Accuracy of irradiation is difficult to obtain by this method and the skin reaction is severe. Protection of the scrotum is necessary and a sheet of lead 2 mm thick placed on the thighs can be used for this purpose. The patient should be informed of the possible damage to the testes.

*Interstitial radium*—By this method greater accuracy of radiation is ensured and a high tissue dose of 6 000r to 7 000r can be delivered. The risks of a radium burn are greater but the chances of a permanent arrest of the disease are excellent in suitable cases. A general anaesthetic is required and a dorsal slit is carried out if there is any degree of phimosis. The needles containing 0.5 mg or 1 mg of radium are placed at the base and periphery of the lesion, additional small needles are placed in the centre. Alternatively radon seeds can be used instead of radium needles. The seeds should have adequate platinum screening. The needles or seeds must be placed equidistally and extend beyond the actual lesion so that the edge of the growth is fully irradiated. The needles are left in position six or seven days. The total tumour dose reached is about 6 000r to 7 000r or even more. The reaction is severe but localized to the area treated, it subsides in two or three weeks and healing is complete in five to six weeks after the removal of the needles. The scar is sound although telangiectasis develops frequently within a year of the treatment.

*Treatment of the inguinal lymph nodes*—The presence of enlarged inguinal glands does not necessarily indicate their invasion by metastasis. Most primary lesions on the penis are infected and the early enlargement of the regional glands is often due to sepsis. If the treatment of the primary lesion is by radiation, no decision should be taken as regards the glands till the result of treatment on the primary growth can be assessed. In many cases the inguinal adenitis subsides during the irradiation period. The cases fall into one of the following categories: (1) those without palpable glands, (2) those with palpable but operable glands, and (3) those with fixed glands. The first group should be given the benefit of the doubt and kept under observation, no treatment is indicated. The second group should be treated by radiation. The method of choice is teleradium if a unit containing 2, 4 or more grams of radium is available, treatment should however, not be prolonged if regression of the glands is not obtained in one month after a delivery of 5,000r to 6,000r to the glands. As an alternative to teleradium, surface radiation by means of sorbo rubber plaques can be given. If regression is not obtained surgical excision of the glands is undertaken, one or both sides are operated on according to the spread of the metastasis. If the glands are fixed or otherwise clinically unsuitable for excision radiation by plaques or teleradium is always worth trying. Temporary regression can be obtained in nearly all cases, in some, the glands shrink and become clinically operable. These cases should be submitted to operation when the skin reaction has completely subsided.

*Summary*—The treatment of the primary growth of the penis by radiation has been reported by many authors. Series up to fifty cases have been described with a 60 to 75 per cent of five years freedom from recurrence. The treatment of enlarged inguinal glands remains still a debatable matter. A combination of radiation and excision offers advantages which in most cases are greater than surgical or radiological treatment alone.

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## CHAPTER LVIII

### INFLAMMATION OF THE PENIS

#### BALANOPOSTHITIS

**B**ALANOPOSTHITIS is an inflammation of the opposing surfaces of the prepuce and of the glans penis. It is usually mild with trivial symptoms but occasionally sepsis may be violent enough to cause gangrene, septicæmia and death. It is liable to occur in cases of phimosis because accumulations of smegma, epithelial debris, etc. may set up irritation and permit pathogenic organisms to flourish. Also repeated attacks of inflammation may cause infiltration and scarring and make matters worse by increasing the phimosis.

Lack of cleanliness, an irritating urine, the use of unsuitable lotions, the handling of certain chemicals in various trades, or the presence of local sources of irritation such as may occur in penile or urethral inflammations may be factors in the ætiology of this malady.

In mild cases there are no constitutional effects and local symptoms cause only mild itching and burning. Retraction of the prepuce reveals an accumulation of evil smelling smegma and the underlying surface of the glans and the inner preputial lining present patches of redness and desquamation. Later superficial ulcers may develop with slightly necrotic and indurated edges and if the inflammation invades the deeper tissues slight œdema, especially of the prepuce, may occur and may render retraction of the prepuce difficult and even lead to paraphimosis.

**TREATMENT** consists in enforcing strict cleanliness and irrigations of the preputial sac. If the prepuce can be retracted this is easy, but if not the cavity should be thoroughly washed out by means of a suitable nozzle. Symptoms generally subside rapidly, but if ulceration is marked a thin layer of gauze soaked in a mild antiseptic lotion may be introduced within the prepuce and frequently changed, though the presence of swelling or phimosis may make this impossible. If the inflammation is acute or if paraphimosis has occurred it is advisable to slit the prepuce along the dorsum to permit adequate treatment. No extensive incision should be made or a spreading cellulitis of the penis may ensue. A circumcision to prevent further attacks should be done later when the case is quiescent.

After repeated attacks of balanitis, especially in the young, it may be found that the prepuce has become more or less extensively adherent to the glans and may need careful separation. The external urinary meatus may also be extensively scarred and constricted and may require a meatotomy.

**Erosive balanitis**—The foregoing is a description of simple balanitis, a trivial ailment and one usually easily cured. There is however a more severe type of balanoposthitis which may be much more serious. In this there is a profuse foul yellowish white discharge, the preputial cavity is lined with greyish white patches and the inflammation may involve the anterior urethra. The patches are composed of desquamating epithelium and when removed leave a raw eroded surface. This disease has been termed erosive balanitis and as it spreads small multiple ulcers appear, their bases being slightly

indurated and covered with a false membrane. They vary from about  $\frac{1}{16}$  in to  $\frac{1}{4}$  in in diameter are usually clean cut but may coalesce and involve the whole surface of the glans. The disease is sometimes mildly contagious and may be transferred by coitus or other means.

A competent bacteriologist is needed to elucidate the complex picture of staphylococci streptococci *B. coli* diphtheroids etc. with perhaps a spirillum and vibrio in some cases like those seen in cases of phagedena. Spirochaeta or Treponema refringens and various other forms sometimes of an anaerobic type often make the bacteriological analysis confused and difficult.

A mild case commences with itching and burning of the prepuce and glans, and a profuse foul discharge appears. The prepuce and penis become oedematous and much enlarged. A certain amount of superficial sloughing takes place and the process tends to terminate and to heal without further incident.

Treatment consists in retracting the prepuce free irrigation the application of repeated fomentations and the frequent use of hot baths.

In the type of case so far described constitutional symptoms are almost absent but with a deeper spread of the infection sloughing and gangrene may occur and the patient may become extremely ill. The temperature and pulse rate rise and he suffers from anorexia nausea vomiting repeated chills and rigors. The whole penis may become enormously swollen and tender with a reddened indurated and oedematous prepuce. Blackened areas may appear and if necrosis occurs much of the penis may become disintegrated and slough away. Such cases are often difficult to distinguish from syphilis or chancreoid but the absence of the *Spirochaeta pallida* or of the Ducey bacillus will settle the point.

These cases are not of venereal origin and it is not yet demonstrated definitely that contamination with saliva or oral types of bacteria are necessary for their production. They may occur in patients with depressed local and general health so that when repeated attacks of balanitis occur it is always well to make a general examination for such diseases as diabetes gout or any local constitutional source of irritation such as an excessive output of urates phosphates etc. in the urine.

As these infections follow filth and neglect in dealing with a dangerous microbe invasion of an organ which under certain circumstances may lack natural and adequate surgical drainage prompt and efficient treatment is necessary because there is always the possibility of phagedena and gangrene supervening.

**TREATMENT**—The area must be completely cleansed and the preputial sac opened up by retraction in the early stages if necessary by a limited dorsal slit. The inflamed surfaces must be irrigated with oxydizing washes such as permanganate of potash or peroxide of hydrogen to discourage anaerobic growth and when spreading gangrenous cellulitis has occurred free incisions should be made to try to check the necrotic process. Treatment may be complicated by the simultaneous presence of chancre or of chancreoid but in all cases the situation must be treated seriously and the patient confined to bed and a general regime against sepsis instituted.

The above are the main types of primary balanoposthitis but inflammation and ulceration of this region may follow bruises or chemical irritation. Balanoposthitis due to definite organisms—Cases of balanitis occur generally in those of uncleanly habits in which bacteriological investigation sometimes reveals the association of a spirochaete with a fusiform bacillus together with a general contamination of staphylococci streptococci etc. This is like the condition seen in a case of Vincent's angina or noma and is a gangrenous

type of balanitis causing considerable destruction. Treatment follows the same lines as those already laid down with the giving of sulphonamides and the local application of novarsanobillon in glycerine which has proved useful in some cases. When the bacteriology is indicative of its use penicillin should be employed.

Occasionally a severe balanitis is encountered which may spread to the penis and scrotum. The ulceration is superficial in type with a base covered with a greyish dirty membrane. It occurs after circumcision in children and sometimes in adults after salivary contamination. The causative organism is the Klebs Loeffler bacillus which may be extremely difficult to isolate.



FIG. 321

Diphtheritic infection of the penis and urethra in a man aged 45 (D. N. E. Berry's case)

Such cases have been described on several occasions by Berry (1932) Prinzing (1928) and others. They are treated by injections of anti diphtheritic serum and may be followed by various forms of paralysis.

On rare occasions a greyish membrane forms on the glans corona and prepuce due to *Oidium albicans* (Thrush). It may follow intercourse and causes a certain amount of local irritation. It can be treated with an antiseptic wash such as 2 per cent. resorcin.

Anthrax causes a few cases and nearly always occurs amongst workers in hides. It is a violent and dangerous disease and its treatment must follow the lines laid down for it in other situations.

**Sequelæ**—A variety of late complications may follow cases of long continued balanitis amongst which carcinoma of the penis is perhaps the gravest. Chronic thickening of the epithelium of the glans and prepuce has been described in the form of various types of keratosis and after many years of

chronic catarrhal inflammation leucoplakia has been noted. This presents all the characteristics usually seen in other situations and should be regarded as a precursor of malignancy.

Kraurosis of the prepuce and glans similar in every way to that seen in the female may occur extremely rarely after prolonged balanitis in the aged.

### PREPUTIAL CALCULI

These are sometimes the direct result of inflammation in the preputial sac (for details see p. 957).

### INFLAMMATION OF THE COVERINGS OF THE PENIS

Inflammations of the coverings of the penis are not common and may be divided into two classes—primary and secondary.

Primary acute idiopathic inflammation of the penis is rare but the symptoms are often fulminant, with the rapid onset of necrosis and gangrene a fatal termination occurring in a few days from septic toxæmia. If not so immediately fatal acute sepsis may involve the penis, scrotum and perineum etc. gangrenous phenomena appearing about the third day and causing much destruction before the case terminates by resolution or death. The effects are often like those seen in gas gangrene infections in other situations.

Bacteriological examination reveals a variety of mixed organisms streptococci staphylococci various strains of diphtheroids proteus gas forming organisms anaerobes etc. The disease is noteworthy for the rapidity of its onset its extreme severity and for the widespread destruction that may be caused by it.

A painful spot appears somewhere about the penis and a pronounced edema spreads rapidly until in a few hours the penis may become two or three times its usual size. The septic centre becomes red, tender and painful and the skin over the affected area darkens in colour assumes a dirty dusky hue and gradually presents a somewhat glazed and greasy appearance. On the second or third day black patches appear and gangrene is fully established, may spread rapidly and when gas forming organisms are present crepitus may be felt in advance of the central area and a characteristic odour becomes a marked feature. In some types the phenomena are like those occurring in so-called extravasation of urine with an extensive spreading cellulitis of the subcutaneous lymphatic tissues. An incision through the still living skin will reveal greenish stinking necrotic tissue beneath it. The overlying skin soon sloughs and the sepsis may spread beneath the deep fascia and involve the corpora cavernosa and spongiosum though interference with the function of the urethra may be a comparatively late symptom. Septic intoxication is profound and usually appears quite early though symptoms may be relatively mild until the onset of gangrene. In the gangrenous stage however intoxication deepens markedly pyrexia is high the pulse rapid and weak mental wandering and delirium are common and the patient passes into a state of profound septicæmia until death occurs.

In the less fatal types there may be much local destruction of the genitalia half or more of the penis being lost and only a twisted distorted stump remaining. The scrotum may be almost entirely destroyed leaving the testes denuded of their coverings and hanging loose on the spermatic cords.



## SECONDARY GANGRENE OF THE PENIS

The disease follows various conditions the clinical picture differing little from those already described. It occurs occasionally in diabetes mellitus arteriosclerosis etc. and after local traumatic and septic conditions affecting the external genitalia such as crushes lacerations heat and chemical burns or exposure to extreme cold. It may follow an abscess of the penis of any type and even after a dorsal sifting of the prepuce so that this incision should always be as limited as possible. Gangrene may follow the neglect of dressings over penile ulcers etc. and may occur after the use of metallic or rubber rings slipped over the penis to assist erection. Septic necrosis may follow thrombosis of a penile varicosity or after the infection of a penile cyst and a spreading pelvic cellulitis commencing in the region of the vesical neck may pass along the whole length of the urethra and appear as a spot of gangrene on the glans penis. This appearance with its deep seated origin is almost always of fatal significance.

Although gangrene of the penis is extremely dangerous the septic process may terminate at almost any stage and healing by granulation sometimes occurs with remarkable regeneration of tissue.

## TREATMENT

In all cases of severe sepsis of the genitalia treatment must be general and local. General treatment consists in immediate confinement to bed on a light diet with free catharsis and diuresis. One of the modern sulphonamide preparations should be given and every means adopted to conserve the strength of the patient against the profound toxæmia. blood and saline transfusions being valuable. Penicillin should be used when the bacteriological picture reveals an infection by organisms which are influenced by this agent. Anti gas gangrene and anti streptococcal serum are productive of beneficial results from time to time. Frequent applications of hot moist dressings locally irrigations and the use of hot baths all help to limit the spread of sepsis. Surgery should be reduced to a minimum in the acute stage though free multiple incisions may be required to stem the spread of subcutaneous necrosis and a suprapubic diversion of the urine should be established in all severe cases.

The sloughing stage sometimes terminates with remarkable abruptness the sloughs separate and healing by clean granulation occurs. Later plastic surgery may have to be adopted according to the needs of the particular case and Thiersch pedicle whole and split skin grafts may all be useful on various occasions to minimize the effects of extensive destruction.

## OTHER CONDITIONS

There are a large number of minor inflammatory conditions which may affect the penis and which although comparatively trivial often cause much discomfort.

HERPES ZOSTER occurs and runs the same course as elsewhere with pain along the affected nerve. Small vesicles form break down cause small shallow ulcers which ultimately heal and disappear.

A more common affection is that known as herpes progenitalis. There is a collection of small vesicles round the region of the corona and glans which burst and give rise to small ulcers. They rapidly yield to treatment by attention

to cleanliness the use of saline or mild antiseptic irrigations and the application of a tringent powders. Occasionally the disease is transferred by coitus and if neglected may lead to one of the more violent infections already described. The first symptom noted before the appearance of the vesicles may be mild stinging and irritation later the erosions may become encrusted with secretions and epithelial debris. The disease sometimes follows the habitual passing of septic urine and a neglect of strict cleanliness. It may be markedly recurrent and has been thought to be due to a form of filter passing organism.

MALIGNANT DERMATITIS of the penis and scrotum has been described occasionally and is like the condition found in the breast. It causes an indurated area of chronic inflammation and infiltration of the squamous layer of the skin in which the typical Paget cells are observed on microscopic examination. Such cases have been recorded by Kidd (1929) and others. The lesion is superficial is usually situated upon the glans and presents a raw red base with a slightly serpiginous margin. It should always be regarded as a precursor of cancer and treated accordingly by excision or by radiotherapy.

GRANULOMA URETHRALE is a disease seen in the tropics and in Southern Europe. It may affect the coverings of the penis and sometimes the deeper tissues causing urethral stricture occasionally. Microscopical examination of the discharges and of the tissues reveals the presence of *Leishman Donovan bodies*. The glands in the groin may become infected and may break down causing suppurating buboes. Such cases have been described by Milligan and others and can often be successfully treated with antimony preparations.

*Scabies eczema*—especially the variety known as *eczema intertrigo*—*mycotic infections erythema multiforme lichen planus* and *psoriasis* usually only a part of a more widespread affection all occur on the penis. They belong more to the domain of the dermatologist than to that of the urologist.

For venereal lesions see pp 781 and 833

### CAVERNOSITIS

For idiopathic cavernositis see p 606

Inflammation of the substance of the corpus cavernosus and may be either acute or chronic.

Acute cavernositis—Acute infections may follow wounds bruises or as an extension from a near by septic area such as an inflamed urethral stricture—especially after unskilled instrumentation—or it may occur as a pyæmic metastasis.

A mass of induration develops in the substance of the corpus which becomes tender on pressure and may press upon the near by urethra causing difficulty of micturition. The penis may be held erect by the filling of the corpus and owing to the inelasticity of the contained lesion it may deviate towards the affected side. If a true erection occurs it may cause extreme pain.

Suppuration may ensue and is especially likely in the pyæmic cases and should be dealt with promptly to prevent the pus from discharging sinistaneously into the urethra and on to the skin and so causing a penile fistula.

Fatahties are not uncommon in the pyæmic cases but are mostly due to the gravity of the underlying condition.

TREATMENT—The treatment of acute sepsis of the corpora cavernosa follows the usual lines—oft repeated hot fomentations baths short wave diathermy etc. An abscess may often be successfully treated by aspiration though this may have to be repeated on more than one occasion before resolution occurs. The needle should be introduced obliquely into the cavity so

that a valve-like track may prevent the formation of a fistula. Should aspiration fail a limited incision may be necessary.

**Chronic cavernositis**—Chronic inflammation of the corpus cavernosum, plastic induration of the penis or Peyronie's disease rarely follows the acute type which usually heals either without trace or by leaving only a small residual scar. Chronic inflammation has as yet no certain aetiology and occurs among all classes of society generally between the ages of 40 and 70.

The rigidity and melasticity of a section of the corpus may cause marked curvature of the penis on erection the rigid segment pulling the distal portion of the organ towards the side of the lesion. This unusual bending may be the first sign of the illness, the early stages of which are frequently quite symptomless. As the disease progresses, however pain at the base of the penis may be noticed on erection, but more often than not the trouble is first discovered accidentally. Progress is extremely slow, and years may pass before the patient begins to complain.

The affection usually commences either at the penile angle or at the distal ends of the corpora cavernosa just behind the corona and it will often be found on examination that there are areas of thickening in the sheath of one or both corpora. These areas tend to spread slowly and irregularly and may invade the septum between the two cavernous bodies but rarely attack the corpus spongiosum. Signs may be noted first in the mid-line beneath the dorsal vessels, and usually spread from before backwards causing either single or multiple plaques in the sheath of the corpus or saddle like thickenings, cord or ring shaped indurations, or deeply seated nodules, or the whole body of the corpus may become infiltrated and a state of false priapism may be produced.

These indurations are firm and elastic to the touch and only attack the fibrous tissue of the sheaths. In the later stages the swellings may become stone like in hardness.

Two types superficial and deep can be distinguished. In the former the disease affects the outer layers of the sheath of the corpus, whilst in the deep variety it attacks either the septum between the two corpora or the fibrous layer between the corpora cavernosa and the corpus spongiosum. It is a rare and obscure condition and seems to be a true fibrosis with little evidence of inflammation, so far, attempts to implicate some special infection have failed. Microscopically it is a fibrosis which in the later stages may be partly transformed into areas of cartilage and even bone. Also calcareous deposits apart from the true bony nodules are met with occasionally.

Except for the malformation the disease may be practically without symptoms, but sometimes there is pain and tenderness at the base of the penis and, as the distortion increases, coitus may become difficult or impossible, causing much mental worry and distress. In other cases, the power of erection is lost, and there is also some difficulty in micturition and ejaculation in the late stages, but, as a rule, the urethra remains unaffected, micturition and ejaculation continuing to be normal. Owing to the prolonged course of the disease a variety of sex neuroses make their appearance and the prognosis is always doubtful.

**Diagnosis**—The disease must be differentiated from benign tumours, ordinary scar tissue, trauma, gummata, various scleroses, gouty tophi, areas of thrombosis, fibromata, etc., which may all involve the substance of the corpus itself unlike a true chronic cavernositis.

**Treatment**—This is unsatisfactory. Claims have been made for the employment of short-wave diathermy, X-rays and radium have only given

disappointing results, and the injection of such substances as fibrolysin have proved useless. Definite nodules may be dissected out, but this line of treatment should be restricted to the more superficial types and should not be undertaken until the disease is at a standstill. If such a dissection has to be extensive, plastic surgery may be needed to fill the resulting gap.

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## CHAPTER LIX

### INFLAMMATION OF THE SCROTUM

THE skin of the scrotum has both hair follicles and sweat glands and contains loose areolar tissue in which the testicles with their own particular coverings are embedded

Major inflammations affecting the whole organ are not common but once sepsis has established its foothold it may be violent spread widely and if gangrene occurs the necrosis may extend to the penis perineum and even to the abdominal wall as well

*Pediculi scabies pruritus and anal sinuses and fissures proctitis hæmorrhoids colitis and constitutional diseases* such as glycosuria gout etc may set up inflammations of the scrotal skin which are usually trivial but which may become severe and even dangerous In bygone days chimney sweeps suffered from a chronic scrotal dermatitis caused by soot and sometimes developed chimney sweep's cancer if the irritation was of sufficient duration

If inflammation invades the *sweat and hair follicles* an abscess may follow glands may become blocked causing sebaceous cysts which if infected may also cause trouble later *Traumatic lesions* after crushes bruises and wounds may become septic and this may also follow such measures as vasectomy the tapping of a hydrocele or the injection of a hydrocele with sclerosing drugs if there is any fault in the aseptic technique Sepsis may also spread from neighbouring organs from the penis from a fracture of the pelvis involving the pubic ramus from the urethra or following infections of the testicle

Sometimes special infections occur either primarily or as a secondary invasion from an already existing lesion Diphtheria of the scrotum has been described by Martini (1938) and others its course and appearance is similar to that given when describing penile diphtheritic infection

Cases of *actinomycosis* of the scrotum have occurred in workers with straw barley etc and the possibility of actinomycotic infection with its prolonged period of incubation should be borne in mind in any case of chronic inflammation of the organ The swelling produced is usually markedly indurated and may be composed of multiple hard nodules which break down and form sinuses in the discharge from which the typical sulphur granules can be demonstrated As a rule the inguinal glands are not affected and the diagnosis is made on the discovery of the mycetium Treatment consists in the use of X rays and the administration of iodides

In the tropics *amœbic infections* have been described usually commencing in the perineal or anal region whence they may spread to the scrotum and sometimes become gangrenous

*Granuloma inguinale* already noted in connection with the penis may attack the scrotum It usually appears first in the form of multiple papules or small nodules in the scrotal skin These become eroded on the surface slightly indurated and produce shallow ulcers They are apt to recur may cause much scarring and occasionally become chronic with but little tendency to heal The inguinal glands are often involved and break down readily, producing the suppurating bubonic condition which gives the name to the

disease. It is caused by an infection in which Leishman Donovan bodies can be found and which can be treated with antimony preparations.

*Paget's disease*, like that of the penis and breast, has been described, and produces a lesion in every way similar to that seen on the penis.

Once the scrotum has become infected in any manner the skin becomes thickened, tender and indurated. The subcutaneous tissue may be involved and the organ may become rapidly more or less oedematous, sometimes producing enormous enlargement. It should not be forgotten, however, that sometimes oedema of the scrotum may occur in other fluid-forming diseases, such as nephritis or cardiovascular conditions, so that in a case of unexplained oedema of the scrotum the possibility of such an illness should be suspected and investigated. Occasionally these inflammations may become chronic and produce considerable infiltration and swelling of the scrotal tissues, lasting as long as the primary source of infection remains, perhaps for weeks or longer. Nowadays, however, long-continued chronic scrotal inflammation is rare, and the once well-known chimney-sweep's dermatitis has now almost entirely disappeared. Cases of cancer do, however, occur occasionally. Tuberculosis and elephantiasis of the scrotum are dealt with elsewhere.

### GANGRENE OF THE SCROTUM

The most important infections of the scrotum are those which lead to gangrene and, like such cases affecting the penis, may be either primary or secondary to some existing disease.

Primary idiopathic gangrene of the scrotum occurs in middle-aged persons of dirty habits. Bacteriology reveals the presence of the staphylococcus, streptococcus, often streptococcus hæmolyticus, *B. coli* in large numbers, various anaerobic organisms, *B. welchii*, *aerogenes capsulatus* and other gas-forming types which are usually mixed in various combinations and amounts.

Gangrene of the scrotum is happily not a common disease, but cases are seen from time to time and are rather more common than the similar state in the penis. It appears with an unheralded fulminating onset, is often rapidly fatal and is similar in every way to idiopathic gangrene of the penis except that the scrotum is attacked first. Although no cause for the disease can be demonstrated, it should be remembered that the scrotal skin is of considerable extent and much wrinkled, so that a minute port of infection may be easily overlooked and quickly lost in the enormous oedema which is so rapidly produced.

A typical case appears in apparently perfect health, may run an extremely rapid course, speedily attacking the skin and subcutaneous tissue, and assuming the characteristics of a gangrenous lymphangitis followed by a rapid thrombosis of the blood supply and spreading necrosis. The explosive onset, which may commence in one or more areas simultaneously, causes speedy destruction, and greyish spots of gangrene have been noted as early as forty-eight hours from the outbreak of symptoms. As in the case of penile gangrene mortality is high, being between 26 and 30 per cent. The patient becomes profoundly ill with pyrexia, high pulse rate, nausea and vomiting, pallor and prostration, chills and frequent rigors and delirium, sometimes maniacal in character, may occur. Occasionally general symptoms are delayed until the appearance of gangrene, but in the most acute cases deep toxæmia may be observed from the outset which becomes more and more intense until the case terminates in septicæmia and death.

In a typical case, if death from toxæmia does not occur within the first

two or three days the skin becomes reddened, tense and glossy, is hot and extremely tender becoming somewhat greasy with a moist exudate. A foetid odour like that met with in the penile cases is also a marked feature in many instances. Desquamation occurs and simultaneously oedema of the scrotal sac develops often of enormous extent. Crepitus may sometimes be felt in the regions round the septic centre if gas-forming organisms are present. The spread of the oedema is limited by the well known attachments of the fasciæ of Colles and Scarpa which determine the distribution of the infection and the areas of destruction.

Gangrene makes its appearance about the third day spreads rapidly, and may arise occasionally in more than one area simultaneously. Sloughing is attended by considerable pus formation, and the tissues may suffer extreme destruction which may spread to the penis perineum, deep into the ischio-rectal fossa, and up onto the abdominal wall. The loss of scrotal tissue may be so extensive that the whole organ may elough away, leaving the testicles exposed and denuded to their tunicæ albugineæ but apparently uninjured by the violent inflammation which has taken place around them. Such cases have been described with comparative frequency Carver (1939) and others having given more or less similar accounts.

Sometimes the phenomena are similar to an attack of erysipelas, and if gangrene occurs, it may suddenly cease to advance, with only circumscribed destruction. A line of demarcation makes its appearance, and the sloughs commence to separate in two to seven days after the acute process ceases. Secondary hæmorrhages are liable while the sloughs are being detached. The necrotic tissue sheds away, leaving a clean, raw, granulating surface denuded of skin, and with the separation of the sloughs a rapid improvement in the general health occurs and convalescence may be comparatively short. Regeneration may progress to a remarkable extent, a great part of the scrotum, which was apparently destroyed being replaced, though plastic surgery may be needed to produce a satisfactory result.

The diagnosis of this disease is made on its fulminating character, the complete lack of any apparent cause, and the appearance of the acute manifestations in the scrotum.

Treatment must be general and local and follows in all respects that already described when dealing with a similar infection of the penis. Penicillin or sulphonamide treatment is valuable according to the nature of the infection.

Secondary gangrene of the scrotum is similar in its manifestations to the idiopathic variety already described, but follows as the result of some definite cause, often obvious. It may occur during general illnesses, such as typhoid, measles, influenza, etc., or in the course of constitutional states such as diabetes, gout, arteriosclerosis and nephritis, or after a local source of infection, such as periurethritis, epididymitis or orchitis, or after traumatic lesions produced by blows, heat, cold etc. It may be part of a neighbouring area of gangrene such as may have originated from the penis, or around the anus following sloughing hæmorrhoids. It may occur after the injection or tapping of a hydrocele, and has been observed in infants when it may sometimes have spread from an area of sloughing round the umbilicus. It runs a course similar to that seen in the various types of idiopathic gangrene, and the methods to be used for its treatment are the same.

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## CHAPTER LX

### NON-SPECIFIC URETHRITIS AND INFLAMMATION OF COWPER'S GLANDS

**POST-GONOCOCCAL URETHRITIS**—In the pre sulphonamide era residual urethritis due to non specific organisms frequently followed an attack of gonorrhœa and without doubt was then the commonest cause of this type of infection. There was always the possibility of gonococci lurking in the deeper tissues and repeated bacteriological examinations were necessary during subsequent treatment.

Since the introduction of sulphonamide therapy and penicillin non specific urethritis following an attack of gonorrhœa is also of frequent occurrence (more so after penicillin) but in my opinion some of them are avoidable.

Unavoidable causes are resolution processes in gonococcal lesions, urethral stricture, primary mixed infections of gonorrhœa and non specific urethritis, pre existing lesions of the upper urinary tract and in rare cases intrameatal warts. The avoidable causes are faulty technique in lavage, the use of strong irrigating solutions and tests for cure carried out immediately on completion of course of chemotherapy or penicillin. In this way the recently inflamed urethral mucous membrane and the glands which open into the urethra are traumatized and inflammation of the prostate, vesiculæ seminales, glands of Littre and Cowper's glands is likely to follow.

We shall now consider the varieties of urethritis in which the gonococcus has played no part or no recent part.

The incidence in my practice and my out patients at St Peter's Hospital is 31 per cent.

#### ÆTIOLOGY

##### 1 Venereal—

- (a) Primary urethritis (bacterial and abacterial) due to intercourse with a consort suffering from leucorrhœa or rectal coitus
- (b) Syphilis (three stages)
- (c) Chancroid
- (d) Lymphogranuloma inguinale
- (e) Intercourse leading to infection with protozoa, metazoa and fungi
- (f) Stricture

##### 2 Traumatic—

- (a) Internal violence such as undue instrumentation and the use of hot sounds
- (b) External violence including masturbation
- (c) Irritation from macroscopic bodies including calculi
- (d) Irritation from microscopic bodies as the crystals of oxaluria and phosphaturia
- (e) Irritation from an indwelling catheter
- (f) Chemical irritation of external origin arising from prophylactic syringing and the use of chemical contraceptives
- (g) Chemical irritation of internal origin following drug administration and the excretion of certain articles of diet (including alcohol)



- 3 *Infections descending from prostate bladder or kidneys*
- 4 *Systemic diseases*

Intra urethral herpes which does not fit into the above classification may also cause non specific urethritis and there are conditions (urethrorrhoea prostaticorrhoea spermatorrhoea) which may simulate a urethritis

### VENEREAL CAUSES

**Primary non-specific urethritis**—Intercourse with a consort suffering from leucorrhoea so often accompanied by a cervical lesion is particularly likely to be infective immediately before or after a period. Of the existence of this contagion there is no doubt as on several occasions I have treated two men infected by the same consort moreover I have often had the opportunity to examine both the man and the woman isolating the same organism from each.

This type of urethritis may be also contracted by rectal coitus

**BACTERIOLOGY**—*Before treatment* staphylococcus albus is most frequently found. Next in frequency are diphtheroids streptococcus haemolyticus or faecalis and Gram positive and Gram negative diplobacilli there may be mixed infections. B coli sometimes occurs in combination but I have not seen it alone which is surprising in urethritis from rectal coitus. Primary B coli urethritis is most likely to occur when foreign bodies contaminated with the organisms are inserted into the urethra. A good example is the case reported by Romanis and Mitchiner (1941) of a medical student who while conducting experiments on the temperatures of the orifices of the body transferred a thermometer direct from his rectum to his urethra.

*During treatment* coliform organisms may appear in discharge and urine endogenously by absorption from the colon or exogenously by faulty technique in lavage and instrumentation. Staphylococcus aureus is rarely found but when present presages more serious suppuration and constitutional disturbances.

The non specific organisms seen in smears and cultures of the discharge are not always responsible for the urethritis in some cases the disease may be due to a virus or pleuropneumonia like organisms. Inclusion bodies in the cytoplasm of epithelial cells in the urethral discharge were described by Landner (1910) in five cases of Waelsch urethritis and he considered that the virus was identical with that of trachoma. I have found inclusion bodies in cases of non specific urethritis which did not have the urethroscopic picture of Waelsch urethritis. Inclusion bodies have also been observed in both the fathers and mothers of babies suffering from inclusion blennorrhoea (Heymann 1910).

Pleuropneumonia like organisms may also be pathogenic in some cases of non specific urethritis. These organisms in one phase filterable and until recently grouped as filterable viruses have been cultivated from urethral vaginal and cervical discharges (Demes (1940) Demes and Smith (1942) and Beveridge (1943)). Beveridge obtained positive cultures in four of twenty four cases of non specific urethritis in the male and in recent series I obtained positive cultures in five of nine cases of acute non specific urethritis and in seventeen of fifty with Waelsch urethritis. The elementary bodies described originally by Landner may be the granular phase in the development of pleuropneumonia like organisms as in some of my cases a small percentage of them are ring shaped.

The incubation period is usually seven to thirty days but in some cases

signs and symptoms clinically indistinguishable from gonorrhœa develop in three days

THE SYMPTOMS AND SIGNS are generally milder than in gonorrhœa. The discharge is less purulent and less profuse and often appears at the external urinary meatus as a colourless viscous secretion with or without a plug of mucus. The appearance of the urine in the two glass test and urethroscopic picture of the anterior urethra are as in acute gonorrhœa.

There is a type of urethritis (Waelisch 1916) due to pleuropneumonia like organisms or virus in which symptoms are slight and which at the first examination looks like a long standing infection. I have often passed a urethroscope at the first visit and have seen the typical picture of sago grain urethritis.

**Diagnosis.**—Both smears and cultures are essential. Organisms are usually difficult to find in smears if correctly taken and before treatment it is rare to see them in large numbers. They may be intracellular or extracellular in position. The number of pus cells varies. They may be numerous or as few as ten to a one twelfth field. Incidentally the importance in these cases of a thorough cleaning of the glans penis and fossa navicularis before taking specimens for cultures cannot be too strongly emphasized since staphylococcus albus and diptheroid bacilli are normal inhabitants of the glans prepuce and fossa navicularis. The urethroscopic picture of the anterior urethra in Waelisch urethritis shows large numbers of greyish white nodules situated chiefly on the roof and lateral walls which are not at all unlike sago granules and resemble the lesions of trachoma.

A specimen of blood should also be taken for a Wassermann Kahn and gonocœcal fixation reaction. The last is usually negative when there has been no previous attack of gonorrhœa but a previous attack especially one of long duration may leave large amounts of gonocœcal antibody in the serum causing a positive reaction though the gonocœcal infection has disappeared.

**COMPLICATIONS.**—*Symptomless prostatitis* is frequent as the posterior urethra is always involved. *Acute inflammation of the prostate vesiculae seminales*. *Couper's glands* and *epididymes* is rare and invariably due to urinary instrumentation or prostatic massage. *Suppurative epididymitis* is more frequent than it is in gonorrhœa. *Inguinal adenitis balanitis infections of para urethral ducts and glands* and of *Tyson's glands* are seldom seen. *Warts* (condylomata acuminata) are also infrequent (they only developed in 4 per cent of my cases and when intrameatal in position had caused resistant infection). *Urethral abscess* is in my experience usually seen in association with urethral stricture. *Cystitis pyelitis pyelonephritis pyonephrosis* and *perinephritis* result from ascending infections especially when *B. coli* or *staphylococcus aureus* is present. Such infections predispose to urinary calculi. *Acute arthritis* is rare (in my series there were forty cases two mono articular and thirty eight polyarticular and in five of these cases iritis and conjunctivitis co existed).

A syndrome which includes non gonocœcal urethritis polyarthritides conjunctivitis and keratoderma blennorrhagica is now known as *Reiter's disease*. In the original case described by Reiter in 1916 blood cultures yielded two types of spirochæte but in all the cases since recorded in the literature blood cultures have been negative. In five recent cases under my care I have observed inclusion bodies in the urethral discharge conjunctival secretion and skin lesions but the elementary bodies (some of which are ring shaped) may be the granular phase in the development of pleuropneumonia like organisms.

**TREATMENT.**—The general principles of treatment are identical with those of gonorrhœa. I prescribe both sulphonamide therapy and urethrovessical

*irrigations* *Chemotherapy* may profoundly modify the disease but the percentage of failure is much higher than in gonorrhoea, and if one sulphonamide fails, recourse to another is rarely successful. Success depends largely on the organism responsible. *Hæmolytic streptococci* and *coliform bacilli* yield rapidly; *staphylococci* and *diphtheroids* often resist until the eighth or tenth day especially when there is gross involvement of the posterior urethra. *Streptococcus faecalis* is frequently resistant. Infections due to a virus or pleuropneumonia-like organisms are in my experience, resistant to both the sulphonamides and penicillin.

I prescribe sulphapyridine or the less toxic sulphathiazole. The patient takes 1 gm of sulphathiazole six hourly for five days and continues, if the urine remains muddy or contains threads, for a further four days with a dose of 1 gm eight-hourly. Four grammes of sulphapyridine are given on the first day, 3 gm daily for six days and 1 gm twice a day for four days. Sulphadiazine in the same dosage as sulphathiazole has recently given me good results.

*Urethrovessical irrigations* are given twice daily with warm solutions of oxy-cyanide of mercury 1 in 4,000 (usually preferable in this type of infection), but any weak and warm antiseptic solution, including potassium permanganate, is effective.

So far penicillin, in my experience, has proved ineffective in the treatment of non specific urethritis, as organisms susceptible to the antibiotic are rarely responsible for the infection.

If clinical cure (no discharge and urine clear with no threads) is obtained on completion of course of chemotherapy, treatment is discontinued and tests for cure are carried out later but if the discharge persists or the urine contains pus it is essential to investigate the lower urinary tract.

*Instrumentation* is necessary when urethroscopy reveals folliculitis or soft infiltrations. This involves weekly dilatations with Kollmann's anterior dilator or massage over a straight sound followed by an irrigation with oxy-cyanide of mercury 1 in 4,000. Dilatations are continued until urethroscopy reveals a normal anterior urethra.

Acute infections of the prostate vesiculæ seminales and Cowper's glands are treated as in gonorrhoea, but in subacute or chronic infections urethrovessical irrigations should be continued, if, however, these are ineffective it is advisable to combine them with gentle massage of the affected organ once a week only. Perseverance may be necessary, but remember always Janet's profoundly true observation that prostatic massage has produced epididymitis more often than it has cured prostatitis.

*Fever therapy* occasionally effects rapid cures in resistant cases and failures often respond to further chemotherapy as in gonorrhoea. It is the treatment of choice in cases suffering from arthritis.

Systemic fever may be induced by (a) the intravenous injection of a stock vaccine, (b) physical means (hypotherm), (c) the intramuscular injection of heteroproteins such as sterile milk, (d) the intramuscular injection of chemical substances such as sulphur and (e) inoculations of malaria. The method most favoured for the treatment of urethral infections and their complications is the intravenous injection of triple typhoid vaccine (anti-typhoid-paratyphoid, T A B). This is diluted down to 250 million organisms per c.c., the first dose being 0.2 c.c. or 50 million organisms. The temperature usually begins to rise after one or two hours and ranges between 102 degrees Fahrenheit and 105 degrees Fahrenheit. If the result is not satisfactory 0.4 c.c. is given on the following day but if a good reaction has been obtained the same dosage or

0.3 cc is given. The injections are repeated as soon as the temperature returns to normal. If the fever is unsatisfactory divided or coupled dosage is invariably successful the second injection (same dose as first) being given two hours after the first but only if the temperature has not registered higher than 103 degrees Fahrenheit. In uncomplicated cases two bouts of fever are usually necessary but complications such as arthritis require at least five.

In syphilis an intrameatal chancre (one must be particularly on the lookout for this) mucous patch or gumma may cause a mucopurulent discharge (see Syphilis).

Soft sores in the meatal region are usually accompanied by similar lesions elsewhere on the genitalia (see p. 782).

Lymphogranuloma inguinale, when the primary lesion is intra urethral may cause urethritis. It may be accompanied by oedema of the prepuce with infiltration of the dorsal lymphatics and the virus may also invade the posterior urethra. Even though there may be no enlargement of the inguinal glands the deep iliac glands are always involved. A positive Frei's reaction clinches the diagnosis. Sulphonamide therapy is effective and the urethritis needs no special treatment.

Protozoa, metazoa and fungi have been noted as causing urethritis of these the protozoon trichomonas vaginalis is the most important. In the female trichomonas may cause vaginitis or may be present without symptoms. In the male symbiosis with streptococci or staphylococci is the probable cause of infection. Strongly alkaline urine is said to inhibit the development of this condition.

For diagnosis add a drop of urethral discharge to an equal quantity of normal saline and examine under a one twelfth objective preferably with a dark ground illumination (with ordinary illumination it is necessary to cut off the peripheral rays). The parasite is then seen varying in size from one and a half to two and a half times the size of a pus cell. It is actively motile and has four flagella in continuous activity. (Incidentally the parasite may be found in the preputial sac or urine as well as in the urethral discharge.) The treatment is as advised for primary non specific urethritis.

Urethral stricture (including traumatic stricture) as cause of urethritis must not be overlooked. The attack is often precipitated by excess of intercourse or alcohol in a patient with infected urine. Treatment consists of dilatations and irrigations. Chemotherapy often stops the discharge but relapses after further instrumentation are frequent.

### TRAUMATIC URETHRITIS

When the urethral mucous membrane is damaged saprophytic organisms normally present in the fossa navicularis may become pathological or other organisms may be admitted.

External injuries to the urethra internal violence such as undue force in instrumentation or the passage of hot sounds and irritation from foreign bodies (including calculi) may precipitate non specific urethritis but irritation from microscopic bodies such as the crystals in oxaluria and phosphaturia is seldom responsible.

An indwelling catheter invariably produces urethritis the organisms commonly found being cocci especially staphylococcus albus also a haemolytic micrococcus producing a greenish growth on haemoglobin agar often appears. The infecting agents may also be other micrococci and streptococcus faecalis. Usually the growths are pure and there is no difference in the severity of the

infections caused by these different cocci. They all clear without treatment in a few days and the urine is usually sterile after a week. The prognosis differs when the *B. coli* or *B. proteus* group is found in the urine during catheterization or on removal of a retained catheter. Such infections invade the entire urinary tract and before the introduction of the sulphonamides were often resistant to treatment.

**Chemical urethritis** arising from prophylactic syringing with strong solutions is frequently seen. The incubation period is usually less than it is in gonorrhœa, a discharge often appearing in two to three hours, swelling and distortion of the penis may be marked but in most cases inflammation is confined to the urethra.

Traumatic urethritis may also follow the use of chemical contraceptives.

Chemical irritation of internal origin following *drug administration* (cantharides, turpentine, potassium nitrate, potassium iodide, arsenic and sodium bicarbonate) and the *excretion of certain articles of diet* (spinach, strawberries, sorrel, beetroot, cress, asparagus, mustard, pepper) said to cause urethritis rarely do so.

Cantharides and turpentine do certainly contain a volatile oil irritant to the kidneys and mucous membrane of the urogenital tract, but I have never seen primary urethritis follow the administration of iodides, though often in patients taking iodides an existing urethritis is aggravated by mercurial irrigations. Mercuric iodide precipitates on the mucous membrane of bladder and urethra produce severe and often alarming symptoms such as painful and frequent micturition, but these acute symptoms usually subside within an hour, especially when fluids are freely taken.

Sodium bicarbonate renders the urine alkaline and causes a precipitation of phosphates, and a whitish discharge may be noticed at the end of micturition, smears show large numbers of granules of amorphous phosphates and pus cells are seldom found.

Beetroot, sorrel, spinach and strawberries are rich in oxalates and may cause oxaluria. Alcohol in excess is an irritant to the urogenital tract and may cause primary urethritis but in most cases the discharge descends from a pre-existing and latent prostatitis.

**Treatment**—Urethritis due to trauma may in most cases be cured by removing the exciting cause.

### INFECTIONS DESCENDING FROM PROSTATE, BLADDER OR KIDNEYS

A patient may occasionally give a history of recent exposure to infection whereas the true explanation of the urethral discharge is a lesion of the upper urinary tract. Obsessed by the possibility of venereal infection, he may overlook other symptoms of gradual onset and longer duration. If there is pyuria unaccompanied by lesions in the anterior or posterior urethra, an investigation of the upper urinary tract (which must include X ray examination, cystoscopy, pyelography and examination of the urine for tubercle bacilli) becomes necessary.

This type of urethritis may be caused by infections of the prostate secondary to kidney and bladder infections or to infection from remote foci, e.g. boils. The prostate may also be the focus in senile enlargement or calculi of the gland, and I have seen cases in association with an infected malignant growth of the bladder, vesical diverticulum, ureterocele and bilharzia.

Non-specific urethral discharge may be the only symptom of calculi anywhere in the urinary tract.

In my records there are twelve cases of urogenital tuberculosis which in the first place were considered to be suffering from non specific venereal infections. Frequency of micturition of several weeks duration was a prominent symptom. Tubercle bacilli were found in the centrifugal deposit of a twenty four hour specimen of urine in eleven cases once in the urethral discharge in a patient with gross involvement of prostate and vesiculae seminales and three times in pus aspirated from suppurative epididymitis.

The treatment of urethritis due to descending infection is that of the underlying pathological condition.

### URETHRITIS DURING THE COURSE OF SYSTEMIC DISEASES

This has been observed in mumps measles malaria influenza staphylococcal septicemia Malta fever typhus typhoid fever and diabetes.

During an influenza epidemic I treated several cases of prostatitis associated with urethral discharge. There had been no venereal exposure and urethrovaginal irrigations effected cure in most cases two developed prostatic abscess.

In typhoid fever a whitish urethral discharge containing pus cells and intracellular typhoid bacilli has been described as occurring during the third week. Gangrene may follow and Maresch and Chiari (1931) describe one case of thrombosis of the right corpus cavernosum.

My belief is that the urethritis described in gonit is usually a mistaken diagnosis for balanitis just as in diabetes there is often a balanitis due to the irritation of sugar. A co existing urethritis is uncommon.

### INTRA-URETHRAL HERPES

I have seen four cases of this and in three there were also lesions on the glans penis. Acro urethroscopy revealed scattered vesicles or shallow ulcers but the slight discharge disappeared after a week without local treatment. Klausner (1911) reports a case of stricture following repeated attacks.

### URETHRORRHOEA SPERMATORRHOEA AND PROSTATORRHOEA

These conditions may simulate non specific urethritis. In urethrorrhoea a clear viscid secretion of mucus and epithelial cells presents at the meatus following prolonged but ungratified sexual excitement.

Spermatorrhoea is the discharge without erection or desire of seminal fluid usually following defecation or micturition. Smears show motile or non motile spermatozoa and the urine may contain sago bodies or amorphous vesicular debris which disappears on addition of acetic acid.

In prostatic prostatic fluid escapes during defecation or at the end of micturition usually in patients with a history of previous prostatitis.

Diagnosis is easy if microscopic investigations are always carried out remembering Janet's dictum that the diagnosis of urethral infections without resort to a microscope is like a deaf man undertaking the diagnosis of pleurisy or a blind man venturing into ophthalmology.

### NON SPECIFIC INFLAMMATION OF COWPER'S GLANDS

In the pre sulphonamide era inflammation of Cowper's glands was a frequent complication of gonorrhoea but since the introduction of chemotherapy it only occurs now in a small percentage of drug resistant cases. On the other hand

involvement of these glands in non specific infections of the urinary tract has always been infrequent and in my experience is often associated with urethral stricture. The latter condition has even been known to lead to calculi in the gland—Laquiere and Bouchard (1926). Tuberculous infections of the glands have been reported by Englisch (1885) and Hartmann and Lecene (1903) and on one occasion I saw tubercles in the region of the openings of the ducts but an investigation of involvement of the glands was omitted. Congenital cysts occurring both in the bulbar and diaphragmatic glands are usually only diagnosed when they give rise to urinary symptoms.

Infections with non specific organisms may occur in either the bulbar glands (situated in the spongy tissue of the bulb) or the diaphragmatic glands (situated between the two layers of the triangular ligament) they may be acute or chronic.

*Acute infections of the bulbar glands* have the same signs symptoms and treatment as a perurethral abscess of the bulbous urethra. The swelling may cause retention of urine.

*Acute infections of the diaphragmatic glands of Couper* are usually unilateral and the symptoms are similar to those of acute prostatitis or prostatic abscess. There is perineal pain (particularly on rising or sitting down) with pain and frequency of micturition and in 30 per cent of my cases there has been retention of urine. With adequate treatment the acuteness may subside but in many cases the abscess which forms does not remain localized in the urogenital diaphragm. The pus often tracks downwards and presents as a perineal ischio-rectal or perianal abscess but it may also track upwards and form a peri prostatic or peri rectal abscess. Fistulae which may or may not communicate with the urethra usually follow spontaneous rupture of an abscess.

*Diagnosis*—Bi digital rectal examination reveals an acutely tender and thickened urogenital diaphragm on the side affected. When the abscess has tracked upwards or downwards it will be felt to be in direct communication with the primary swelling between the two layers of the triangular ligament.

*Treatment*—There are many failures with chemotherapy as the organisms responsible are often insensitive to the sulphonamides. Infections due to *B. coli* usually react rapidly to sulphathiazole or sulphadiazine (1 gm. six hourly for five days with a loading dose of 2 gm.) but if an abscess has formed incision and drainage are essential before chemotherapy begins. Fistulae sometimes persist and in these cases the remains of the gland must be excised before a cure can be effected where there is retention of urine catheterization may be necessary. Penicillin (60 000 units three hourly for five or six days) is effective when the organism responsible for the infection (e.g. *S. aureus*) is susceptible to the antibiotic. Abscesses become sterile during treatment but if they do not burst spontaneously aspiration or incision is usually necessary. Absorption of the pus rarely occurs in large abscesses.

*Chronic infections of diaphragmatic and bulbar glands* may follow acute infections but in my experience the onset is insidious in a large majority of the cases since non specific urethritis even when it is complicated with a low grade infection of these glands is often symptomless the discharge being so slight that the disease is usually overlooked. This may account for the fact that involvement of the glands is occasionally diagnosed in patients with no history of urethritis or urinary infection.

*Diagnosis*—Bi digital rectal examination is the most useful aid in diagnosis. The urogenital diaphragm first on one side and then on the other is grasped between the forefinger (in the rectum) and the thumb (on the perineum).

the bulbar glands being situated near the mid-line in the spongy tissue of the bulb. Normal glands are not palpable but diaphragmatic and bulbar glands, if they are chronically inflamed are of hard and bricklike consistency varying in size from a pea to a hazel nut. Occasionally there is only a thickening of the urogenital diaphragm and this is usually so when there has been a previous acute inflammation.

Aero-urethroscopy is a useful aid in diagnosis and often reveals a thickening of Cowper's ducts with bogginess and thickening of the mucous membrane in this region. There may be small or large dilatations, single or double (usually referred to as congenital cystic dilatations of Cowper's ducts) which are often, but not always, seen in association with inflammatory changes in the glands. Smaller openings into the ducts are occasionally seen, usually where the ducts from the bulbar glands (which are usually multiple) join the main channels. It should be noted that the larger cystic dilatations may obstruct the passage of instruments and for this reason are sometimes mistaken for stricture or false passage.

*Treatment*—Sulphonamide therapy, prescribed in the same dosage as for the acute infections, is occasionally effective but in my experience penicillin is rarely so. Local treatment consists of urethrovesical irrigations with oxycyanide of mercury 1 to 4,000 combined with massage of the gland. In three of my cases excision was carried out for relief from perineal pain. In each case the urine was clear with no threads and the glands free from infection, sections showed a marked peri-cowperitis and a normal glandular epithelium.

It must be remembered that in many cases the glands remain palpable after eradication of infection.

A. H. HARKNESS

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## CHAPTER LXI

### INFLAMMATORY URETHRAL STRICTURE

**STRICTURES** of the urethra are not so common now as they were twenty years ago. Improvement is due to increased pathological knowledge and better treatment of the primary cause. The municipal venereal clinics have attracted patients in the early stages of disease, and the prohibition of treatment by unqualified practitioners has undoubtedly been beneficial to the patients.

**Definition**—Stricture has been defined as an "abnormal contraction of some portion of the urethral canal," or as a "condition in which it (the urethra) has lost the power of dilating." This alternative definition is too general and not so accurate, for with advancing years some amount of atresia occurs in the urethral canal, and full-sized bougies cannot be passed without discomfort, even in patients giving no history nor exhibiting signs of stricture.

**Ætiology**—Inflammatory stricture is gonococcal in origin in 98 per cent of cases. In a few rare instances the tubercle bacillus has been the primary cause. The chronicity of the infection, not the acuteness, is the main factor. Chronic gonorrhœa is never a single organismal infection, and the chronicity may be prolonged by the other organisms present.

**Pathology**—In the acute stage of infection the mucous membrane becomes œdematous and congested, and there is marked periurethral round cell infiltration. The congestion may be so extreme as to cause retention of urine, even necessitating a suprapubic drain. When the congestion and round cell infiltration persists, invasion by fibroblasts occurs giving rise to the condition known as hard infiltration. There is metaplasia of the columnar cells of the mucous membrane into squamous cells and patches of leucoplakia appear. From time to time the superficial layer of cells desquamates and these desquamations are passed in the urine as urethral flakes. In due course, it may be two or it may be several years the periurethral fibrous tissue contracts, and so a stricture is eventually formed which gives rise to symptoms.

The number of strictures vary, and may be single or multiple. As many as eleven have been reported, chiefly diagnosed clinically by means of the olive headed bougie. At autopsies no more than four definite contractions have been found. In general it may be said single strictures are common, two are uncommon and three are extremely rare.

Strictures of the urethra are of two main types—permanent and transitory. The transitory stricture may be spasmodic or congestive. An acute urethritis with œdema may cause retention of urine and yet may resolve and no stricture follow. Spasm of the urethra may be caused by cold, inflammation or injury. A permanent stricture is organic, and the result of chronic inflammation or trauma. It is permanent because it cannot disappear or resolve by the unaided action of the body. The congestive or spasmodic stricture cannot be demonstrated post mortem, but most museums have specimens to illustrate the types and variations of permanent stricture. That a spasmodic stricture can occur is due to the presence of involuntary muscle around the urethra and in the corpus spongiosum. A permanent stricture may be aggravated by congestion

or spasm and thus cause transient retention. Permanent strictures may be of many varieties but three general types are recognized —

- 1 There may be a thin membranous diaphragm the orifice being centric. With thickening of the tissues the term *whipcord* or *annular* is applied the appearance suggesting that a piece of string had been tied round the canal at one point.
- 2 Bridle stricture due to folds of mucous membrane adhering together the orifice being lateral or oblique and often duplicated.
- 3 Ribbon stricture if these bridle strictures run in depth e.g. more than  $\frac{1}{4}$  in.

Strictures may also be described as *resilient* or *gristly*. A *resilient* stricture is one which dilates readily on instrumentation after which it immediately contracts and obstructs the flow of urine. A *gristly* stricture is one associated with intense periurethral induration and is rigid and appears to be almost cartilaginous in nature.

There are three regions of the urethra liable to stricture. Chief of these is the bulbous portion near to the membranous urethra then the penile urethra about  $\frac{1}{4}$  in from the external meatus and least often in the region of the glans. Seventy per cent of strictures occur in the bulbous urethra. There are no recorded instances of stricture of the prostatic urethra. It is difficult to understand why not for chronic posterior urethritis and prostatitis are common in prolonged or badly treated gonorrhoea and when at rest every where the urethral mucous membrane is thrown into folds and is approximated. In the region of the bulb and the membranous urethra the canal is chiefly under voluntary muscular control and these are the chief sites of stricture. There are no special muscles however in the penile urethra nor in the region of the glans yet these regions though to a lesser degree are also commonly affected. There is no known cause why stricture should occur in one part of the urethra in preference to another.

**Complications.**—Untreated or maltreated stricture may have serious consequences. Back pressure on the urinary stream causes dilatation of the ureters hydronephroses and vesical diverticula with the result that a certain volume of urine becomes static and prone to infection. In the vicinity of the stricture rupture of the urethra may occur with abscess and fistula formation and urinary extravasation. In neglected cases marked perineal induration is present and urinary fistulae may be multiple. In carcinoma of the urethra it is sometimes impossible to say whether the carcinoma has originated in a fistula primarily or in the urethra. The diagnosis of carcinoma is often only made after microscopy of curettings from a fistula. Stricture is said to be a cause of carcinoma of the urethra. There is no direct evidence of this beyond the fact that cases of carcinoma give a past history of stricture. It must be remembered however that carcinoma of the urethra is rare while stricture is very common—so common in fact that it would be improbable to find carcinoma in a case that did not have a stricture.

Calculus formation whether renal or vesical may be secondary to stricture because of consequent urinary stasis and infection.

Prostatitis and epididymitis frequently occur in stricture cases. Polyp may also be present and will recur unless the stricture be adequately treated. Retention of urine is a serious outcome of stricture. Apart from the damage to the upper urinary passages and the development and spread of infection retention is often the cause of extreme personal discomfort and pain. Acute retention may occur if the patient has had to avoid micturating for some

time after the urge to micturate has denoted a full bladder. This may happen in certain social conditions or ceremonial surroundings. It may also be brought about by cold, alcoholic or dietary excess. Primary rupture of the bladder through over-distension with urine is unknown, but a distended bladder is very liable to rupture from external violence. An attack of urethritis may occasion acute retention.

Chronic retention gives rise to infected urine, with its well-known sequelæ. In long-standing cases overflow incontinence may follow, necessitating the use



FIG 322  
Normal urethra.

of a portable rubber urinal, or his clothing may become soiled and the patient thus rendered socially objectionable because of the urinary odour emanating from him.

**Symptoms**—These may become evident within a few months after an attack of gonorrhœa or may not occur until many years later, long after the urethritis has been forgotten, and in these cases the onset of acute retention may be the first and the only symptom.

*Gleet* is the usual condition complained of when stricture symptoms appear shortly after an attack of gonorrhœa. It is a chronic urethral discharge, due to an excess of mucous secretion. The discharge contains some pus, and is opaque, milky or yellowish, and stains the linen. It is aggravated by cold

weather Occasionally the discharge has been so profuse as to be mistaken for a gonorrhœa and in consequence has been wrongly treated and has persisted Gleet causes no urethral discomfort All urethral discharges should be examined microscopically in which case gleet will be readily recognized and further investigations as to the cause instituted Chronic inflammation proximal to a stricture granulations and polypi will generally be found Excessive treatment of a gonorrhœa by urethral lavage and instillations has been said to cause gleet but this is only correct provided a stricture is present because



FIG 323  
Normal urethra

otherwise the discharge ceases soon after treatment is suspended A chronic gleet should always make one suspect the presence of a stricture and lead to a complete urethral examination

*Alteration in the flow of urine* is also an early complaint A forked or spiral stream is due to the current of urine being so deficient both in force and volume that it is unable to expand fully the lips of the meatus As the degree of the contraction of the stricture progresses the urinary stream becomes smaller and more feeble until finally it escapes only in dribbles or while a poor stream is flowing some drops may simultaneously fall from the meatus and soil the clothing Although the contractile force of the bladder is increased and augmented by abdominal straining there is little momentum

in the current flowing through the urethra distal to the stricture and in contrast with what formerly happened the urine is projected to but a little distance. There is delay in starting the stream and much straining may be necessary before the urine will begin to flow. After the act of micturition has ceased a few drops may dribble away and wet the clothes due to the fact that proximal to the stricture the urethra is dilated and forms a reservoir of varying size which is not emptied by the time the bladder is fully contracted and from which later the urine slowly trickles away through the stricture.

*Frequency of micturition* is another common complaint. This occurs both by day and night and may lead to such lack of sleep as to impair health.



FIG 3-4  
Stricture

Apart from chronic inflammation of the urethra proximal to the stricture and of the base of the bladder frequency is due to the deficient emptying of the bladder at each act of micturition so that the bladder sooner becomes distended again and therefore must be emptied oftener than formerly. That the bladder fails to empty itself completely at each act of micturition is due to the vesical detrusor becoming tired and also to the patient becoming tired of straining. Eventually in neglected cases the muscular effort to overcome the obstruction of a stricture may be ineffective and *complete retention* occurs or so great that the urethra may rupture proximal to the stricture and cause *extravasation of urine*. Pain of an aching type is often experienced in the perineum and sometimes in the testes. Chronic congestion and straining may give rise to *piles*, *anal incontinence* and *hemorrhoids*.

*Enlargement of the penis* occurs in severe cases due partly to a state of chronic congestion and partly to increased bandling of the penis the patient trying to assist the passage of urine by elongating or milking the penis and thus producing a partial vacuum. This enlargement subsides however as treatment by dilatation progresses.

Nocturnal emissions become more frequent and impaired virility often accompanies hypertrophy of the penis

Infection in long standing cases may occasion symptoms presenting renal or vesical characteristics or there may be malaise with slight general rheumatic or toxic pains

**Investigation**—Investigation of a case of stricture with modern methods gives accurate and precise information. The mere fact of a stricture existing can easily be inferred from a history of the case and by passing a bougie but for successful treatment further knowledge is necessary

*Urethroscopy* should be undertaken in all cases of stricture before treatment is commenced. With the methroscope the size and situation of a stricture



Fig 3 a  
Stricture

can be adequately assessed, also the elasticity of the tissues near the stricture and the presence or absence of false passages. The degree of inflammation or congestion seen may render advisable preliminary treatment of the urethritis before proceeding to instrumentation. Stricture due to carcinoma may be recognized, and also the futility of attempting to pass bougies.

*Urethrography* is a valuable aid. Whereas urethroscopy will only show the surface appearance of a stricture, X rays will reveal the length and tortuosity. They will also demonstrate the depth of false passages and the degree of dilatation proximal to a stricture. The extension of fistulae and pouches and the presence of calculi will also be shown.

**Treatment**—In treating stricture two considerations must be borne in mind. Firstly, the urethral canal must be restored to its normal calibre, and secondly, this degree of patency must be hereafter maintained. The modern methods of dealing with stricture are by dilatation or by operation. Treatment by dilatation is the oldest, the simplest, and still the method of choice. Many varieties of instruments have been devised—bougies made of wax, catgut, gum elastic

flexible metal and solid steel also different types of expanding dilators. Sometimes catheters are preferred for if with difficulty a small catheter only can be passed it is possible to fix it in position and thus relieve retention. Bougies exert both a mechanical and a vital action on the stricture. The mechanical action is akin to that of a wedge: a bougie is tapered so when the narrow end is engaged in the stricture and the bougie pushed home then the stricture is forcibly and gradually dilated. Vital action is brought about by retaining the tip of a bougie against the face of a stricture for some time or by leaving



FIG 326  
Mental bougie (Cannj Rjall)

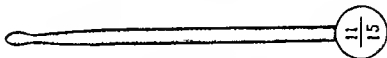


FIG 327  
Anterior urethral bougie (Lister)

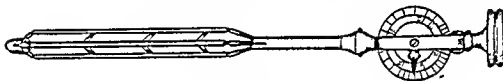


FIG 328  
Kellmann anterior urethral expanding dilator



FIG 329  
Steel bougie (Lister)

the bougie in the stricture. Sometimes a catheter is used instead of a bougie a larger one being inserted after an interval of three or four days. This method brings about softening and absorption of fibrous tissue. An *indwelling catheter* should be of soft rubber or a coude or bicoude gum elastic but not a straight olive head gum elastic one for it must be remembered and guarded against that if the bladder be kept constantly empty the point of the catheter will rest against and may injure the coats of the bladder when pressure necrosis may occur and be followed by fatal peritonitis. The need of gentleness in passing bougies cannot be too strongly stressed and also the evil effects following pain and bleeding. Obvious effort and force must be avoided although gentle pressure steadily maintained without any poking or jerking of the point or relaxing of the hand at one moment and increasing its power at

another will sooner or later overcome opposition and carry the instrument through. Steel bougies of a small size should not be used for fear of making a false passage. A 16/20 Charrière Clutton is the smallest to be recommended. In passing a steel bougie the tip should rest against the floor of the urethra until the bulb is reached and then the instrument should be rotated and the



FIG 330  
Steel Bougie (Clutton)



FIG 331  
Filiform guide



FIG 332  
Gum elastic follower with screw



FIG 333  
Ovary gum elastic bougie



FIG 334  
Posterior expanding dilator (Kollman)

tip kept against the dorsum. With gentle and steady pressure the handle of the bougie should gradually be depressed when practically the weight of the instrument will carry it through into the bladder. The usual fault is not to depress the handle sufficiently. If the patient is lying on a couch then a sand bag to elevate the buttocks will facilitate this latter procedure. When a stricture is fully dilated the steel bougie should require guidance and manipulation only not force. Its weight will be sufficient to enable it to pass through the urethra.



Under no circumstances should a patient be taught and advised to pass a bougie on himself for such a practice is apt to lead to sepsis and injury of the urethra and failure to dilate the stricture fully

Dilatation may be gradual or rapid. The evolution of expanding dilators was from those surgeons who favoured rapidity and who contended that they could quickly cure a stricture. However events showed that strictures rapidly dilated were prone to recur unless bougies were subsequently passed at regular intervals and if this were not done then the ultimate condition was much worse because of increased fibrosis. Rapid dilation is purely mechanical and devoid of vital action *i.e.* the softening and absorption of fibrosed tissue. Rapid dilation by modern methods however is occasionally useful and must sometimes be recommended *e.g.* following internal urethrotomy or for the removal of filiform bougies which have become detached from the follower and left behind in the bladder. It may also sometimes be advisable prior to lithotomy or endoscopic resection of the prostate.

The terms bougie and sound are often used indiscriminately and a solid metal dilator is generally referred to as a sound and a soft gum elastic one as a bougie. As there is a special bladder instrument called a sound for detecting vesical calculi it will probably prevent ambiguity if all urethral dilators other than expanding dilators are called bougies.

The size of a bougie should be gauged on the Charrière scale which is the most extensively used. The Charrière scale progresses by  $\frac{1}{2}$  mm in diameter from No 1 which is  $\frac{1}{2}$  mm in diameter. The English scale increases by  $\frac{1}{2}$  mm from No 1 which is  $1\frac{1}{2}$  mm in diameter. The size stamped on a bougie is often inaccurate therefore the gauge should constantly be used to check the calibre. The largest size passed at each attendance should always be noted.

**ANÆSTHESIA**—A local anæsthetic is generally sufficient to enable the painless passing of bougies but in a few difficult cases to overcome spasm it may be necessary to use spinal anæsthesia. Many drugs have been recommended but the most effective and reliable are cocaine, percamine and phenolaine. A common fault in using local anæsthetics is not to allow the drug sufficient time to become effective. Phenolaine is used in a strength of 4 drops to the ounce and for cocaine All Saint's Hospital formula is recommended.

viz —

Cocaine hydrochloride	6 gr
Sodium bicarbonate	6
Chlorotone	3
Distilled water	$2\frac{1}{2}$ oz

Chlorotone is used chiefly for its preservative action and the solution will last effectively up to a fortnight.

No adrenalin should be added to enhance the local anæsthetic effect which is often done in other parts of the body because the urethra absorbs the adrenalin rapidly and serious systemic symptoms may arise. A 10 c.c. Record syringe is better than the special urethral syringes on the market.

The penis is grasped proximal to the corona by the ring and middle fingers of the left hand and put on the stretch and 10 c.c. of the anæsthetic injected down the urethral canal. The fingers are then replaced by a special clamp to prevent the solution escaping. After five minutes the anæsthetic is milked down into the posterior urethra. This is accomplished by holding the glans with the right thumb and index finger removing the clamp elongating the penis which is then grasped by the left hand and pressure made on the urethra by the index ring middle and little fingers successively and collectively.

and then while pressure is steadily maintained the right hand invaginates the scrotum and pressure is applied by the pulp of the fingers along the line of the urethra down to the anal margin. This movement need only be carried out once and if correctly performed no fluid should escape on releasing the penis. Another injection of anæsthetic should then be given and after five minutes milked down into the posterior urethra.

A local anæsthetic merely dulls the sensitivity of the urethral mucous membrane. It does not affect the glandular portion and it does not prevent pain from overstretching therefore the importance of care and gentleness in passing instruments cannot be over emphasized.

Before injecting the local anæsthetic the patient should be directed to empty his bladder. This will prevent dilution of the solution in the posterior urethra and the escape of urine when Kollmann's dilator is being used. In difficult cases distension of the urethra with 10 c.c. liquid paraffin will facilitate the passage of instruments and in very sensitive patients an intra urethral injection of 2 c.c. gomenol oil (10 per cent) is of great assistance.

**SEPSIS**—Stricture cases are prone to infection therefore every precaution must be taken to avoid introducing infection by instruments. Metal bougies can be sterilized by boiling. Gum elastic bougies can be boiled for one or two minutes and then dried and stored in a formalin vapour chamber. The lubricant should be sterile oil or liquid paraffin or an antiseptic jelly. The glans penis should be thoroughly cleansed especially the meatal opening with an antiseptic solution. The penis should be protruded through an opening in a sterile towel the operator's hands thoroughly disinfected and the instruments if possible only contacted at the handle. The same set of metal bougies can be boiled and used for several cases but gum elastic bougies can be used safely only once in a day for formalin vapour takes some time to become effective.

After bougies have been passed an intra urethral injection of 1 in 1000 acriflavine in glycerine or paraffin is a great deterrent to infection. A dose of quinine (5 gr.) by mouth should be given after every instrumentation. This will prevent mild rigors or a feeling of shivering a few hours later which otherwise many patients complain of. The patient should be advised to drink a pint or two of water before attempting to pass urine.

**DILATATION**—In choosing a bougie for initial instrumentation one may be guided by the size of the stream of urine passed or by the size of the meatal opening. The main principle however is to investigate with a large rather than a small bougie so as not to confuse the issue by producing false passages. Olivary gum elastic bougies are used. Begun with a No 10 F and if this will not pass then try three or four larger sizes and if these fail try descending numbers. Eventually it may be necessary to use filiform bougies. These vary in size from No 1 F to No 3 F. Often a dozen may be in the urethra each being manipulated in turn until luckily one will pass through the stricture. The stricture orifice may be very eccentric so some of the filiform bougies should be pinched so as to tilt the tip. If it is still impossible to engage one of the bougies in the stricture an attempt should be made to pass one under vision through an operating urethroscope. This will sometimes succeed but not in a severe ribbon type of stricture. After a filiform bougie has been passed through a stricture into the bladder a series of ascending sizes should be screwed on up to No 12 F or 14 F. When this size can be passed with ease the filiform guide is no longer required and olivary bougies can be used instead. These should not be passed oftener than once a week so that the tissue reaction can be given time to subside. Olivary bougies should be passed weekly at first and when the larger sizes are reached longer intervals are advisable—

two to three weeks. Start two sizes less than the largest one passed on the previous occasion and finish with the same or one or two sizes larger according to the resistance offered. It is a mistake not to pass at least the same size as at the last treatment. When No 24 F passes with ease gum elastic bougies should be discontinued and the treatment carried on with either metal bougies or with Kollmann's dilator. It is not sufficient merely to pass bougies of ascending sizes; the greatest benefit is obtained when the largest bougie passed is left in the urethra for at least ten minutes and longer if possible.

Alternatively to using bougies screwed on to filiform guides good progress can usually be confidently expected by simply proceeding from the filiforms to the succeeding sizes of gum elastic instruments.

When the treatment is to be continued with metal bougies after full dilatation has been reached the intervals between the treatments are gradually extended from four to six weeks and to two three and six months according to progress.

It may be said that treatment of urethral stricture by Kollmann's dilator safely produces a greater dilatation than is produced by bougies.

The maximum size to which a stricture should be dilated when a Kollmann's dilator is not used varies with individual cases. The decision rests largely on experience. 26 F to 27 F should be regarded as the maximum size in the great majority; it is wise in some cases not to take the dilatation beyond 24 F. Meatotomy is often necessary for this method to be effective.

Over dilatation causes urinary fever and retrogression of the stricture. It is rapid and forcible dilatation that can lead to such dire consequences. Experience shows how easy it is to pass beyond the limits of safety when due care is not exercised.

Kollmann's dilator is a powerful and heavy instrument; therefore when it is passed into the bladder the weight of the shaft should be supported by an adjustable stand so as to take tension off the suspensory ligament; otherwise the patient will complain of discomfort and pain. The Kollmann closed is size No 22 F. The screw should be turned until discomfort is experienced and then left for a few minutes when it will be possible to screw further to a higher reading. At each attendance an increased reading should be registered even though it is only one higher than the preceding and the dilator should be left in at this maximum reading for at least ten minutes. An increased dilatation should not be made if it entails pain or hæmorrhage. Dilatation must be gradual. Eventually dilatation to No 40 F will be tolerated with ease and then the intervals may be lengthened from fortnightly to three weeks four weeks etc. until finally twice a year will suffice. A stricture is never cured meaning by cure that no further treatment is necessary and that it will not recur. Many cases of stricture which have necessitated a filiform bougie to begin with and have successfully been dilated to No 40 F have after two or three years of neglected attendance so contracted down that filiform bougies had again to be employed and the whole sequence of dilatation again repeated.

The value of Kollmann's dilator over the steel is that the maximum dilatation is produced at the site of the stricture which is usually in the region of the bulb; otherwise the meatus must be unduly bruised by stretching if steel bougies of sufficient size to produce this are used. Once the stricture is fully stretched with Kollmann's dilator and shows no tendency to contract if the meatus is sufficiently wide Clutton's steel bougies may be used instead. At this stage a size 28/32 falls in by its own weight and there need be no fear of the stricture giving any trouble or symptoms.

A narrow meatus is more often congenital than inflammatory and is prone to infection. The orifice may be stretched with special mental dilators but it is better to carry out meatotomy after injecting a local anæsthetic. This is often necessary before introducing large cystoscopes or urethrosopes. If the instruments are forced in the orifice tears with subsequent fibrosis and stricture. For this reason mental stricture not uncommonly follows endoscopic resection of the prostate unless the urethral orifice has been fully dilated as a preliminary.

Any of the usual complications of stricture may be caused or rendered more severe by rough and faulty instrumentation. This is always the cause of a false passage hence the need for gentleness cannot be over emphasized.

Shock may follow dilatation even to the extent of causing fatal collapse. It may be due to the toxic effect of the anæsthetic.

Over dilatation may cause spasm and œdema and subsequently acute retention. An old frayed or unsound metal screw connection of the filiform guide may become detached and the filiform left in the bladder. Fortunately the complications are rare.

Electrolysis and diathermy have both been recommended and practised in the treatment of stricture but so far with no noticeable success.

Continuous dilatation by means of a soft rubber tube is speedy and painless but the patient must be confined to bed. It is a method only recommended in certain cases e.g. when suprapubic drainage has to be instituted because of acute retention and a catheter cannot be passed and in cases of severe cystitis. The bladder is opened suprapubically and a filiform bougie passed through the external meatus into the bladder and the tip made to protrude through the wound. A small rubber tube is attached to the tip by means of a silk thread and withdrawn with the filiform through the urethra. A safety pin is inserted through both ends of the rubber tube and this prevents the tube from being withdrawn into the urethra or into the bladder. Every day the tube is secured backward and forward until it moves freely. When the safety pin is removed from one end and a larger tube attached by a silk thread is pulled through. When a size No 24 F passes the bladder opening is allowed to heal and the stricture subsequently dilated with Clutton's bougies or the Hollman's dilator. A dressing soaked with acriflavine in glycerine (1 in 1000) should surround the glans and the tube so as to prevent ascending mental infection. The part of the tube to be pulled through the urethra should be first thoroughly washed and cleansed with antiseptic.

**OPERATION**—*Internal urethrotomy* is an operation of choice not of necessity and by itself does not cure. It must be followed by full sized bougies at regular intervals until eventually twice a year for the remainder of the patient's life.

The best urethrotome is that of Maisonneuve the later modifications having nothing essential to recommend them. The fact that the knife of Maisonneuve's urethrotome travels to the tip of the instrument is not a disadvantage for the flat apex of the blade pushes up the mucous membrane which is healthy and not bound down and the edge of the knife only cuts what is rigid and tough. Though the knife traverses the membranous and the prostatic urethra no cutting is done unless resistance is met and obviously if resistance is met cutting is not heated. In general it may be said that most of the original instruments are best suited for the purpose for which they were invented the subsequent modifications being introduced chiefly for notoriety or self advertisement.

If the stricture will admit a No 8 F Maisonneuve's urethrotome can be easily passed otherwise a special filiform guide must be passed and the cap

removed from the urethrotome, which is then screwed on to the guide. Only one cut should be made, dorsally and in the mid-line. Steel bougies are then immediately passed up to the largest size, preferably Clutton 22/26 F. An intra-urethral injection of acriflavine in glycerine or paraffin is advised before the insertion of the indwelling catheter, a size 22 F. to 24 F. being recommended—the larger sizes encourage urethritis. The catheter should be left in generally for not longer than two days or until the temperature settles, and the bladder should be washed out daily. If an indwelling catheter is



FIG. 335

J S 49 years perineal fistula two months, stricture seventeen years marked dilatation. Acute retention, necessitating suprapubic drain. A week later filiform passed and withdrawn through suprapubic opening, and stricture dilated with see saw rubber tube. A year three months later, all wounds healed. Clutton 24/32 passes easily.

not used the urine will be flowing over a raw surface and rigors and fever will result.

Civiale's urethrotome cuts from behind forwards, and the Otis dilating urethrotome from before backwards. They are passed on a guide but can only be used if the stricture will admit a No. 10 F. bougie. They have nothing to recommend them.

Treatment following internal urethrotomy is similar to that of stricture by dilatation. Full size steel bougies must be passed at lengthening intervals until eventually twice a year for the rest of the patient's life. Otherwise the stricture may contract down again and necessitate the employment of filiform guides and followers. Such a contraction may occur as early as two years after cessation of treatment. Internal urethrotomy by itself is not a cure,

but is merely a safe method of rapid dilatation to be recommended in selected cases. Suitable cases are as follows:—

1. Narrow strictures in elderly people who may soon require prostatectomy or resection.
2. As a preliminary to operative cystoscopy or lithotripsy.
3. In certain cases where it is inconvenient to attend regularly and frequently for treatment.
4. In glisty or resilient strictures which do not readily respond to dilatation.
5. In strictures of the anterior urethra which are not suitable for external operation because of the probability of fistula resulting.



FIG. 336

A D. 56 yr. r. Treated for stricture for thirteen years by bougies could never pass more than F. 13 or 14. This type of case is suitable for internal urethrotomy.

Internal urethrotomy should not be done if the urine is foul and septic; the bladder should first be drained and improvement obtained before the urethrotomy is carried out.

Complications following the operation are sepsis and hæmorrhage, which obviously are slight and infrequent, seeing that the mortality rate of the operation is not more than 1.5 per cent.

External urethrotomy is an operation of necessity, not of choice. It is necessary in cases of impassable stricture or in cases of stricture complicated by perineal fistula. It is only advised in cases of posterior stricture, but as anterior strictures may also be present, Harrison in 1885 recommended a combined operation, viz. an external operation to improve bladder drainage and an internal urethrotomy for the anterior strictures. This procedure is still modern and advisable. The classical operation of Syme is now only of historical interest, but that of Wheelhouse is still practised.

Wheelhouse's operation consists in passing a special grooved staff down to the stricture—the patient being in the lithotomy position—and opening the urethra upon the groove which terminates about 1 in from the end. The staff is then rotated and the upper end of the wound retracted while the edge of the mucous membrane is temporarily stitched to the skin and thus the interior of the urethra is fully exposed. Search is then made for the orifice of the stricture and if found a fine probe passed through it and the stricture divided. A catheter is then passed down the penile urethra and guided through the divided stricture into the bladder. The perineum may then be lightly approximated with sutures. The catheter is left in for four or five days and ten days later bougies are passed. A dye is sometimes injected down the urethra before the operation to facilitate the discovery of the opening through the stricture.

If the orifice can be found and the stricture divided this operation is good. Usually however after a long search the orifice cannot be found and if a probe cannot be passed through the stricture cutting upon it is unlikely to open its lumen. In such a case the stricture is unwittingly by passed and if there is much fibrous tissue present recontraction will readily occur.

Realizing from experience the futility and waste of time in searching for the stricture orifice and the improbability of opening its lumen the following operation is recommended as a routine procedure viz the deliberate by passing of the stricture.

The patient is placed in the lithotomy position a Clutton bougie passed down to the stricture the perineum incised in the mid line and the urethra opened on the point of the bougie which is then made to protrude. A rubber tube is threaded on to the bougie which is then withdrawn. The tube is No 22 F. The bladder is then opened suprapubically and a Clutton bougie passed through the internal urethral meatus until it impinges on the stricture. The urethra is opened on the tip of the bougie which is protruded into the wound the other end of the rubber tube threaded on to it and then withdrawn. Safety pins are made to transfix the ends of the rubber tube so that it cannot be pulled back into the bladder nor through the external meatus. Indurated tissue is removed as far as possible the perineal wound packed with gauze soaked in acriflavine in glycerine (1 in 1000) and if no fistulæ are present the wound may be lightly approximated by one or two catgut sutures embracing the skin and deep tissues. Usually the wound is left to heal by granulations. A separate tube is fixed in the bladder for urinary drainage. Every day the long rubber tube is ~~see sawed backwards and forwards and once a week~~ changed for a larger one up to No 30 F. This tube and the bladder drain are not discontinued until the perineal wound is soundly healed and subsequently Clutton's bougies are passed weekly until size 28/32 passes freely and painlessly. The intervals are then made longer until eventually twice a year for life. The presence of the rubber tube provokes a vital action on the indurated and fibrosed tissue which eventually disappears and the perineum becomes soft and supple. It is advised to use the endothermy knife in making incisions in the perineum otherwise oozing and trickling of blood will obscure the field of operation and the hemorrhage may be difficult to control later. The mortality of external urethrotomy is greater than that of internal. This is due to the complications present prior to operation chiefly local fistulæ and septic kidneys. The mortality is about 8 per cent.

Neototomy may be necessary either for stricture or congenital narrowing. The incision should be made with the endothermy knife dorsally or ventrally or both according to the position of the opening. A catheter should be tied

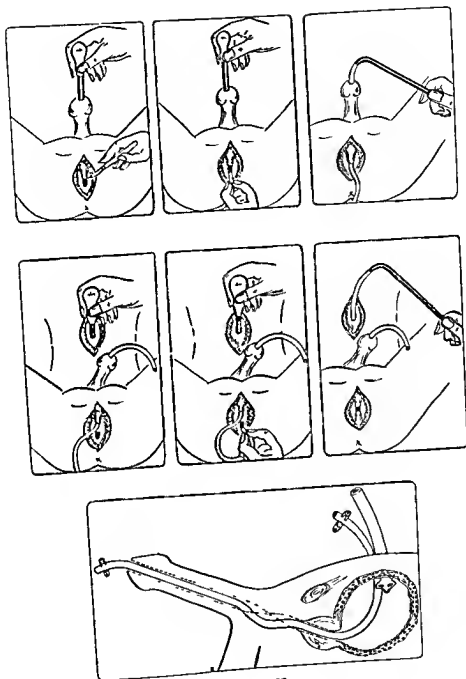


FIG 337



The bladder must be drained suprapubically as is the case in any other plastic operation on the urethra. The excessive fibrosed tissue must be removed as far as possible. It is possible to excise 1 or 2 in. of the urethra and yet mobilize the rest of the urethra to such an extent that end to end union is feasible.

Partial excision consists in removing the floor of the stricture along with surrounding fibrous tissue leaving a thin strip of mucous membrane on the roof. A catheter is tied in and the wound lightly closed. In complete excision the urethra must be freely mobilized the stricture and fibrous tissue removed and the urethra united dorsally. Another method is to incise both cut ends of the urethra so as to form three strips. One is united dorsally and the other two laterally the urethra being left unsutured longitudinally. The wound is lightly closed to allow serum and blood to escape and a catheter is tied in for a few days. A fortnight later bougies are passed.

Attempts have been made to bridge the gap after excision by grafting in a piece of the internal sphenous vein or fashioning a new channel with mucous membrane from either the patient or some other animal. A few successes have occasionally been reported.

Though successes have been reported following excision irrespective of the method employed many failures have occurred with resulting fistula. Excision is a difficult and tedious operation and even if successful must be followed subsequently by dilatation with bougies.

Two other methods have sometimes been recommended to deal with difficult and impassable stricture. One is the establishing of a permanent suprapubic fistula and the other an artificial perineo scrotal hypospadias. Neither of these methods has any merit for even the most difficult and unpromising case will respond to the deliberate by passing the stricture an operation which is simple and effective.

Plastic procedures may be employed figure 338 represents a successful example. F. McG, LOUGHNANE

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## CHAPTER LXII

### PROSTATITIS AND PERIPROSTATITIS

#### ACUTE PROSTATITIS

**ÆTIOLOGY**—Prostatitis may be either acute or chronic. Acute prostatitis which is a comparatively uncommon disease, either occurs as a metastatic condition in pyæmia or is derived from some infected focus or more usually it is secondary to an inflammation in the vicinity. Cases have been recorded in the course of acute fevers such as measles, influenza, scarlet fever or typhoid, and it may follow less important infections of the teeth, tonsils, nasal sinuses, etc. Petersen (1929), Strominger (1926), Girling, Ball and others have described such cases during the course of furunculosis and other infective foci. It also follows occasionally after deep penetrating wounds, compound fractures of the pelvis and gunshot wounds.

Whilst a common origin is from the posterior urethra during an attack of gonorrhœa, non-gonococcal infections are described in some 25 per cent of cases and all the usual organisms may be bacteriologically responsible though coccal infections tend to predominate. Certain special infections, such as influenza, typhoid, etc., have been noted occasionally.

The infection spreads along the various ducts leading into the urethra and may invade the prostate, vesiculæ seminales or Cowper's glands, either singly or in combination, the last-named structures being least commonly affected. Acute inflammations of this type are liable to occur after any injudicious manipulation, and such proceedings should therefore be avoided if possible in the presence of acute or semi acute sepsis.

The suggestion has been made that prostatic massage may force bacteria from the bowel into the substance of the prostate, but anatomical considerations of the distribution of the fascial planes and of the lymphatics will show that this is unlikely. The action of massage is more likely to draw organisms in from the infected urethra, and also it may stimulate infection by bruising the already inflamed tissues.

Any state of lowered resistance in the organ may provide a microbial breeding ground, and such may occur after exposure to cold, acute fevers, sexual excess or local trauma.

**Symptoms and signs**—The symptoms and signs of acute prostatitis are closely akin to those of acute urethritis, and the frequent involvement of the vesiculæ seminales may add complications to the picture. There is usually marked frequency of micturition, dysuria and even strangury, and urinary examination reveals some pyuria. Occasionally the onset is mild with few symptoms suggesting the prostate as the source of the inflammation and in such a case the diagnosis may be difficult. Sometimes the general symptoms of septic intoxication may also be minimal, with a normal or subnormal temperature and little to lead one to suspect prostatitis.

As a rule, however, there is a good deal of general disturbance. The patient becomes suddenly ill, loses his appetite, and has a sudden sharp rise of temperature. Pain occurs locally and may radiate from the region of the prostate, if felt in the abdomen it is sometimes severe enough to suggest some form of

acute abdominal infection. Occasionally the infection reaches the blood stream and causes septicæmia. The swollen prostate may cause some difficulty of micturition and other discomforts. It is sometimes noticed that any discharge which has been seen during the course of the existing posterior urethritis decreases temporarily when the prostate becomes involved. It is usually re-established however in the course of a few days. Hæmaturia is not common.

Pains are generally felt in the lower part of the back, down the legs often at the tip of the penis and there is usually considerable pain and discomfort in the perineum. The patient also feels extremely ill and sexual phenomena may be completely suppressed in the course of prostatic inflammation.

If an abscess should form all the symptoms will be accentuated. An increase of the pyuria is usually noted and is intermittent in character but if the abscess does not communicate with the urethra there may be no augmentation of the pyuria or outward indication of its presence. As a rule when pus forms pain and tenderness increase, retention of urine occurs and the perineum becomes more tender especially when sitting. Owing to the pressure of the faeces defecation may cause severe pain and is suggestive of the nature of the illness as has been noted by Girling Ball (1931) and others.

Sometimes the abscess is subacute and slow to form and Thompson and others have pointed out that some collections of pus may cause only mild effects. Such cases may cause considerable diagnostic difficulties and are often complicated by the simultaneous involvement of the seminal vesicles and infection of the epididymis. If pus has formed a considerable leucocytosis may be present and would be a valuable indication in a difficult case.

**Course and complications.**—These are various. The infection may progress to an abscess, may resolve or become chronic. One or more spots in the prostate may become necrotic and these may enlarge or coalesce into a considerable abscess and destroy much of the prostate. Many cases of prolonged subacute prostatitis are due to multiple collections of mucopurulent material in the badly draining acini of the gland which become distended with the pent up secretions. The position of a prostatic abscess may be difficult to locate especially if there is much surrounding inflammation. Many acute abscesses are posterior to the urethra and close beneath the mucosa through which they often burst causing a spontaneous cure. Such an event should not be waited for too long because if collections of pus are not attended to with reasonable promptitude the abscess may burst and open into other situations outside the urethra forming sinuses in the perineum, groin, etc. and setting up a greater or less degree of periprostatitis. The pus rarely pierces Denonvilliers' fascia to cause a recto-urethral fistula and still more rarely does it burst into the peritoneal cavity to cause peritonitis. The latter event is most uncommon because of the long distance of the peritoneal sac from the prostate.

Usually when a prostatic abscess has burst or is drained it heals leaving practically no ill effects but sometimes only partial drainage is effected and the abscess becomes a chronically infected cavity, exuding pus through a small inadequate opening. General symptoms however subside and beyond some irritability causing frequent or painful micturition with more or less pyuria there may be few other effects. Such cases may result in a flabby condition of the prostate with pyuria, prostatorrhœa, premature ejaculations and impotence and have been described by Farman and others. Cases which are dealt with by surgical drainage usually heal without sinus formation though fistulae may occur occasionally.

**Diagnosis.**—In the presence of local symptoms suggestive of pelvic inflammation the diagnosis of acute prostatic abscess or of acute prostatitis is

usually not difficult. There are general symptoms of a septic infection, and in addition the local symptoms of frequency of micturition, urgency, dysuria, etc. Rectal examination and the discovery of an enlarged, boggy, tender prostate will disclose the nature of the disturbance.

The presence of fluctuation and localized swelling in the prostate may suggest an abscess but if the infection is not severe and the symptoms are mild or if the abscess is deeply placed with a thickened wall it may be a matter of considerable difficulty to be certain of the presence or absence of pus. A definite leucocytosis will be a point in favour of an abscess and an examination of the blood should always be made in any case of doubt.

If the case is seen after acute symptoms have subsided, it may be noticed in some cases that cautious pressure on the swelling in the rectum results in the escape of a marked quantity of pus in the urine, and in such an event, although an abscess in the usually accepted sense may not be present, a collection of purulent material in the acini of the gland may be inferred. The posterior urethroscope may also reveal oedema, septic polypi, enlarged prostatic ducts or follicles exuding pus. Posterior urethroscopy, however, in such cases is a risky procedure and may cause a renewal of the acute inflammation immediately afterwards, so that all such investigations must be carried out with every care. Some authorities have passed a long needle from the perineum into the prostate under the guidance of a finger in the rectum and have demonstrated the presence of pus by aspiration. The method is not devoid of danger and has not been much used in this country.

**Treatment**—General treatment of acute septic infection of the prostate, such as rest, diet, purgation, the drinking of bland fluids and the oral administration of sulphur preparations, or the use of penicillin follows the usual lines. Locally, frequent hot sitz baths, hot rectal douches, etc., should be given and are often successful.

If a definite abscess forms it should be opened. This is usually done by an incision in the perineum and by carrying the dissection down beside and behind the bulb of the urethra, the swollen prostate being opened by blunt dissection in the depths of the wound, usually by plunging a pair of forceps into the abscess cavity. A small tube, piece of rubber dam, or a wisp of packing is then introduced and the cavity is allowed to heal by granulation, which takes place in most cases without incident and without the formation of a fistula. Some authorities prefer a more radical exposure of the prostate in the perineum on similar lines to the perineal excision of the organ, which enables the prostate to be exposed completely and all pockets and pus collections to be evacuated. It, however, considerably increases the severity of the operation and is not productive of markedly better results than those obtained by the above more simple procedure.

If the prostatitis is subacute and if the prostatic abscess is of the chronic type, and when it is reasonably certain that acute inflammation is absent, the posterior urethroscope may be passed and enlarged ducts or badly draining pockets may be opened up by the use of the endothermic loop. In this manner the floor of the urethra, which may form the roof of a poorly draining cavity, can be opened and thereby free drainage provided.

### CHRONIC PROSTATITIS

**Ætiology**—Whilst acute prostatitis is comparatively rare, occurring most often in the relatively young, chronic inflammation is common and mostly affects older men and may be associated with prostatic hypertrophy.

Any condition which leads to pelvic congestion or local loss of immunity is a predisposing cause of chronic inflammation of the prostate. The disease may be extremely chronic and difficult to treat and there is still a general opinion amongst the medical profession that it is either of gonococcal origin or at least a secondary infection resulting therefrom. Such however is by no means true and rather more than 50 per cent of all cases of chronic prostatitis have no history whatever of a previous *Neisserian* infection.

Bacteria often gain entrance to the prostate from the posterior urethra by way of the ducts and whilst infection by way of the lymphatics from the rectum or bowel has not yet been demonstrated metastases from such sources as teeth tonsils throat etc. are beyond dispute and may follow any local depression of immunity. Chronic inflammation may also be a further stage of an acute infection which may have been gonococcal. The seminal vesicles are usually attacked as well and in any case the infection spreads rapidly from one organ to another a combined infection being practically the rule.

Infection may follow acute fevers such as typhoid or scarlet fever or be part of a general genito urinary involvement affecting testes epididymes seminal vesicles and Couper's glands any or all of which may be involved in a bacterial invasion.

In the usual bacteriological picture coccal infections predominate and a mixture of staphylococci streptococci *B. coli* proteus diphtheroids etc. is usually found. The gonococcus if the original cause can rarely be demonstrated in late cases of infection its place being taken by one or more of the above named germs.

**Symptoms and signs**—These are extremely varied and local disturbances may be slight or entirely absent. The presence of chronic prostatitis may therefore remain long unsuspected the only symptoms being those due to the absorption of toxins and giving little indication of their origin. The depression of health may however be out of all proportion to the extent of the prostatic lesion. These patients often complain of a sensation of weight in the perineum of aching in the penis of backache or a heaviness of the testicles. Complaints of pain however are most variable and as the prostatic nerve supply is derived from the tenth to twelfth dorsal the fifth lumbar and the first to third sacral roots pain may be felt along the distribution of any of these nerves. It may be complained of in the groin suprapubic region in the rectum hips thighs knees legs and even as high up as the lumbar region. Pain on coitus is sometimes felt. Some degree of frequency of micturition is nearly always present perhaps greater by day than by night but it may be so mild as to be almost unnoticed. Occasionally there is slight dysuria and there may be a minimal amount of discharge from the urethra which on drying may cause gumming of the meatus.

Rectal examination reveals a somewhat tender or nodular prostate and as the vesicles are so often involved in the inflammatory process they may be found to be thickened also. In some cases slight tenderness and thickening of the epididymes usually at the lower poles can be demonstrated.

The local congestion may set up disturbances in the bowel causing constipation or diarrhoea also the absorption of toxins may give rise to a variety of effects which may be felt in any part of the body.

There may be frequent nocturnal emissions premature ejaculations loss of sexual desire impotence etc. and the patient often becomes neurasthenic and a martyr to morbid fears such as a dread of cancer or of becoming permanently impotent. Sometimes symptoms may not be unlike those of

obstruction to the outflow of urine and may suggest prostatic enlargement or the presence of a urethral structure

**Course and complications**—It will be seen from the above that the effects of chronic prostatitis are extremely varied. The inflammation may be one-sided as a single nodule or it may be bilateral. Sometimes a chronic lesion during the course of treatment may light up and cause an attack of acute prostatitis which however usually subsides rapidly on the suspension of all local manipulation. Attacks of epididymitis are so common that the greatest gentleness must be exercised in every manipulation in such a case.

**Urethroscopy** if performed with proper care, does no harm in a chronic case and will often yield valuable information. In addition to signs of various degrees of inflammation of the posterior urethra such as redness, œdema, slight loss of mobility—as tested by varying the pressure of the fluid passing through the instrument—or engorgement of the verumontanum, the internal meatus may be seen to be swollen with bullous œdema, to project slightly into the bladder and to present an appearance rather like some cases of intravesical enlargement of the prostate. Also, if the urethra be dilated by means of the Kollmann dilator, the size of the canal is generally less than 35 Charrière, whereas the normal is usually over 40 Charrière.

As the disease may last for years calcareous deposits may occur and definite calculi be produced.

The most important result however, of the continued inflammation and infiltration is the onset of fibrosis leading to contraction of the vesical neck and ultimately to urinary obstruction. This change, which used to be known as "small fibrous prostate" or "median bar obstruction," must be considered as important as that of hypertrophied prostate.

In a case in which there has been much chronic suppuration, posterior urethroscopy may show the mouths of widely dilated prostatic ducts, the openings of poorly draining pus cavities, and perhaps occasional pockets containing stones. In most cases however, beyond some congestion and evidence of infiltration little may be seen on this investigation.

Toxic absorption from the prostate may cause a variety of aches and pains which are sometimes the only symptoms. The possibility of this source of infection should never be overlooked in an obscure case of pain in any part of the body, and metastatic infections of the joints causing arthritis, have been noted by many, the knee, sterno clavicular and mandibular joints are amongst the most frequently affected. Metastases in the eye also occur from time to time.

The neurasthenic symptoms caused by the prolonged nature of the illness have already been noted and often make these cases most difficult to handle.

**Diagnosis**—The diagnosis of chronic prostatitis is usually not difficult. Slight urinary symptoms such as frequency, a little pain, on passing water or in the perineum should lead to a rectal examination which may disclose a tender or nodular prostate. The infection may be confirmed by submitting a specimen of the urine after prostatic massage for analysis, when the presence of pus, prostatic threads, commas, and other prostatic debris will establish the nature of the case.

Symptoms are however, extremely variable and the prostate may not be suspected, so that any mild local symptoms of genito urinary disturbance demand careful inquiry. Sometimes the only complaint is that of a sense of weight in the perineum perhaps worse on defæcation or of pains in the hips, thighs, sacral region etc. These should always focus attention upon the prostate. Slight frequency of micturition is nearly always present but may

periods often months really resistant cases will be found to be comparatively few as pointed out by Garvin (1928) and many others

In some cases heating of the prostate by a suitable diathermic electrode, introduced into the rectum for five or ten minutes before massage, will hasten recovery. Also if urethroscopic examination reveals inflammatory lesions in the posterior urethra such as polypi or an unduly congested verumontanum, etc. these conditions may be dealt with by a light endoscopic application of the diathermic cautery any enlarged prostatic ducts being opened up at the same time

If massage is carried out carelessly perhaps too energetically or too often, unpleasant symptoms may ensue, posterior urethritis may increase, epididymitis is always a possibility and even a prostatic abscess may develop. The slightest suspicion of any such event must lead to an immediate temporary suspension of all local manipulations

Treatment by special methods such as general pelvic diathermy, vaccine therapy and many others has produced only disappointing results and has been largely discontinued. Passing a needle from the perineum into the prostatic substance under the guidance of a finger in the rectum, and the injection of a quantity of antiseptic, such as mercurochrome or other mild bactericide has been tried in recent years. The fluid is said to diffuse rapidly through the prostatic substance and to produce a rapid improvement. The needle can also be introduced through the urethra via a urethroscope. Very little experience however, has been obtained of this method in this country, and it would seem not to be free from danger, and pelvic cellulitis, gangrene and pyæmia have already been noted in a few instances

### PERIPROSTATITIS

This may be either acute or chronic and usually follows inflammation of the prostate which has spread from the interior of the organ, often following injudicious instrumentation during an acute attack, the untimely or too vigorous application of the diathermic cautery to the internal meatus or after surgical wounds near the bladder neck. A few cases of infection of the pelvic planes have followed injections for the cure of hæmorrhoids. In the latter instance the infection spreads along the anterior wall of the rectum and crosses Denonvilliers' fascia into the prostatic region. Severe epididymitis and other septic prostatic sequelæ have been noted in some of the latter cases.

Once sepsis has passed out of the prostate it tends to move in certain directions. Direct extension backwards through Denonvilliers' fascia into the rectum occurs rarely because the obstruction set up by this fibrous layer is considerable. If the pus moves downwards towards the triangular ligament, which opposes it below, it may be deflected by the recto urethralis muscle and the central tendon of the perineum into one or other ischio-rectal fossa.

If the inflammation continues the pus will extend a condition of pelvic cellulitis develops or a large pelvic abscess collects. The latter may extend upwards into one or other iliac fossa. If the suppuration reaches the ischio-rectal fossæ it may perforate either into the rectum or through the skin, producing discharging sinuses which are apt to become chronic. Involvement of the recto vesical space may lead to sinus formation in the anterior perineal region, or if the pus tracks upwards the whole recto vesical space may become implicated and the abscess may open into the peritoneum. Involvement of the prevesical space may lead to rupture into the urethra bladder, or the space of Retzius, and, if into the last locality, sinuses may form in the

## CHAPTER LXIII

### INFLAMMATION OF SEMINAL VESICLES, EPIDIDYMES, VASA DEFERENTIA AND TESTES

#### SEMINAL VESICULITIS

**ÆTIOLOGY**—The convoluted nature of the interior of the seminal vesicles and their restricted outlet render them admirable sites for the occurrence and for the retention of sepsis which may result in either acute or chronic phenomena. Acute inflammation of the vesicles is not common and abscess formation is rare.

Infection is generally derived from pre existing sepsis in near by organs the posterior urethra being the most common source though infection may spread from the prostate vas deferens or epididymis if one of these organs should happen to be primarily affected also metastatic infections from distant foci undoubtedly occur.

As with the prostate all inflammations of this region used to be regarded as evidence of either active or passive gonorrhoea but such is not the case and a majority of vesicular infections some authorities say 60 per cent are of non gonococcal origin. All the usual pyogenic organisms may be responsible and may occur as metastases from teeth tonsils nasal sinuses bowel etc. Infection of the vesicles by direct non surgical trauma is exceedingly rare because the organs are fairly mobile deeply placed and the only accidents liable to affect them are gunshot or deep penetrating wounds. On the other hand during operations involving the area of the vesical base such as prosta-tectomy the ejaculatory ducts and vesicles are exposed to injury and may be infected and such occurrences may explain cases of delayed recovery after these operations. Also any increase of local inflammation in the posterior urethra set up by excessive cycling horse riding fatigue chills the careless use of urethral instruments lavage of the posterior urethra with unsuitable or irritating lotions commonly contributes towards the bacterial invasion of the ejaculatory ducts.

In general although acute manifestations are infrequent chronic infections are common events.

**Symptoms and signs**—The symptoms of acute vesiculitis may be difficult to locate. The onset often occurs suddenly without warning with the production of the usual effects of toxic absorption such as nausea vomiting pyrexia etc but without any exact indication of the cause. The symptoms are frequently overshadowed by those due to the simultaneous disturbances in the prostate or posterior urethra from which all the symptoms may radiate without suggesting that the vesicles are involved. There may be sharp pains in the back of an aching or stabbing character or a bearing down pain in the perineum or along the spermatic cords in the testicles or occasionally in the abdomen. The passage of flatus by relieving rectal distension may cause the temporary relief of the symptoms and is a sign which should call attention to this region. The symptoms are much the same as those occurring in prosta-titis though pain on coitus and ejaculation is relatively common. The usual



Symptoms of frequency of micturition dysuria etc. are present as the result of pelvic congestion.

In chronic cases the symptoms just described become relatively milder and occur as a general sensation of discomfort in the pelvis or the perineal region. In such the vesicles are congested though not acutely distended which may lead to an increase of the irritability of the sexual apparatus with frequent nocturnal emissions, premature ejaculations etc. and if these are examined pus (pyospermia) and occasionally blood (hemospermia) in varying amounts may be found. Visible hemospermia may occur occasionally in these congested states.

Rectal examination reveals that one vesicle is large, tender and turgid or that both vesicles are so affected and as the inflammation spreads beyond the limits of the organs a considerable inflammatory mass may be felt or on the other hand the vesicles may feel like flabby fluid containing bags. The inflammation often spreads to the spermatic cords and may involve the epididymes. It will be seen therefore that the symptoms are varied embracing those of posterior urethritis which are chiefly urinary, those due to the vesicles themselves which are mainly sexual and those due to the general disturbances of the inflammation.

Unilateral vesiculitis is rare but the effects may be greater on one side than on the other producing different degrees of distension and swelling. Also some vesicles are relatively hard whilst others feel like soft fluid containing sacs of varying contours according to the effect of the inflammation upon them.

In chronic cases the symptoms may be extremely vague and these organs are often overlooked in consequence. A vesicle may remain in a congested state perhaps for years before it is discovered to be the cause of the patient's ill health. These extremely varied symptoms were ably described by Caulk in the following terms: "Various chronic discharges, many chronic bladder distresses, the numerous referred pains in the back, sacral region, hips, legs, perineum, groin, testicle and penis, recurrent epididymitis, rheumatoid arthritis, arthritis deformans, hypertrophic arthritis, numerous renal cardiac complications, digestive upsets, and an array of nervous and mental manifestations which are almost innumerable."

From this it will be realized that chronic inflammation of the vesicle/seminales can produce an extremely vague and perplexing picture unless these organs are constantly kept in mind. Rectal examination by revealing the indurated or swollen state of the vesicles will usually establish the nature of the case though it should be remembered that it may be impossible to separate any particular symptom as being derived from any particular pelvic organ.

**Course and complications.**—The vesicles are elongated sacs with highly irregular and tortuous lumens having large absorptive surfaces and draining through the ejaculatory ducts which are narrow and rigid and may be further obstructed by the effects of inflammation. This often leads to much toxic absorption out of all proportion to the extent of the actual inflammation.

Fortunately most cases are infected with organisms of low virulence—the catarrhal type of inflammation predominating—so that the effects of severe sepsis are comparatively uncommon. The muco-purulent contents of the vesicles leak slowly away through the ducts and occasionally are expressed by massage as long worm-like cysts. As the ejaculatory and prostatic ducts all open into the posterior urethra, when the latter is infected simultaneous involvement of the prostate and vesicles is almost the rule and if one or other organ is infected metastatically the germs are rapidly transferred to the others.

On rare occasions blocking of the ejaculatory ducts by swelling and pressure may lead to abscess formation which is a dangerous condition and may be followed by peritonitis pelvic thrombosis or septicæmia a few such cases are on record

Usually acute infections of the vesicles resolve fairly quickly and symptoms subside rapidly but they may become chronic with a tendency to the outbreak occasionally of puzzling symptoms which may be difficult to interpret if the original infection has escaped notice

Owing to the extensive area of the vesicular mucosa metastases are likely and absorptive symptoms are more pronounced than in the case of the prostate so that chronic ill health may be a prominent feature of these cases Infections which have become chronic may last for years and are subject to periodic exacerbations the patient never feels really well and complains of effects which may or may not suggest that the vesicles are involved These organs should therefore always be included with the teeth tonsils etc in the list of possible sources of focal infection as being responsible for various forms of arthritis myositis iritis chronic anæmias etc the symptoms of which may be more noticeable than those due to the vesicles themselves

Pressure on the ejaculatory ducts may lead to their occlusion and to a condition of asperma as noted by Kidd (1928) Occasionally the inflammation of the vesicles where they are in contact with the ureters just outside the bladder may set up ureteritis and cause the symptoms of obstruction such as attacks of renal colic and this is thought by some to account for the difficulty in passing ureteric catheters in certain cases

Attacks of epididymitis are common a most frequent and annoying effect which may give rise to considerable scarring and disorganization of these organs and ultimately be the cause of sterility

Deposits of debris may be infiltrated by calcium salts and become vesicular calculi which may attain the size of large shot or peas but are decidedly rare

As in the case of the prostate the prolonged nature of the illness often causes neurasthenic symptoms which may become predominant

**Diagnosis**—The vesiculæ seminales passing upwards and outwards from the upper border of the prostate are not easy to feel in their natural state and are often practically impalpable If however they become distended they may be felt per rectum as soft pulpy swellings the prominence of which may be increased by inflammation The best posture for this examination is the knee elbow position which allows the finger of the examiner good access to the organs especially if counter pressure is made on the abdomen above the pubes The state of the vesicles is determined by noting their consistence degree of distension size tenderness the presence of inflammatory nodules and the degree of fixation to the surrounding tissues and any marked irregularity may have to be differentiated from that due to tuberculosis or neoplasm by a careful consideration of all the concomitant factors

The vesicles may be massaged or stripped in a case of chronic infection which means that the finger in the rectum applies pressure to the upper extremity of the organ and then sweeps downwards and inwards with a view to expressing the vesicular contents into the urethra Urine passed immediately afterwards may reveal pus bacteria or even a worm like cast of muco pus of considerable length which is practically diagnostic of the condition

Some urologists have injected the vesicles with radio opaque substances either by way of the ejaculatory ducts or by vasostomy through scrotal incisions In this manner vesiculograms have been obtained and the presence of abnormalities revealed Catheterization of the ejaculatory ducts is however

often difficult and injection of the vasa deferentia is not always free from undesirable consequences. The frequent occurrence of acute epididymitis and injuries to the vaginal mucosa by the cannula causing obstructive stenosis and possible sterility have led to the abandonment of this line of investigation.

**Treatment**—The treatment of acute and chronic cases of vesiculitis differs considerably. In the acute cases resolution rapidly follows palliative measures in most cases. If the acute symptoms have occurred during the investigation or during treatment or following other manipulations of the posterior urethral area all local interference of an instrumental or digital character must cease immediately. The patient should be treated on general lines for an acute infection and locally gentle heat may be applied by hot sitz baths, hot fomentations to the perineum and pelvis, hot rectal douches or short wave diathermy. As soon as the case has quieted down any marked inflammation of the urethra should be treated by irrigations of the canal with a non-irritating antiseptic by means of the Janet method and when all acute vesicular symptoms have subsided gentle massage at regular intervals should be instituted to expel the contents of the distended organs. The prostate should also be dealt with at the same time. Steady persistence with these methods will usually cause a satisfactory cure though there may be the same need for urethroscopy and the diathermic cautery as in the case of prostatitis.

In the rare event of the formation of a vesicular abscess it may be reached by a deep dissection into the pelvis either suprapubically beside the bladder or by the perineal route by an extension of the technique used for gaining access to the prostate. Wilhelm and others have claimed that a transperitoneal approach is the best permitting good access to the inflamed area through the recto-vesical pouch and allowing large abscesses to be drained transperitoneally by the usual methods. The general cavity of the peritoneum is excluded by packing and a deep narrow wound is avoided. These cases however are individual problems and each must be carefully approached on its own merits.

Chronic inflammation of the vesicles can be dealt with by means of persistent massage and if the infection arises from a distant focus by metastasis this should also receive simultaneous attention. Any accompanying posterior urethritis should be treated by the usual irrigations, instillations, dilatations, etc. Many cases so treated heal completely but a certain number relapse repeatedly and in these treatment is often unsatisfactory.

In a case of the latter type all the usual methods should be tried but the case may prove to be extremely obstinate and various special methods have been devised to overcome the difficulty. At one time it was hoped that large of the vesicles—carried out by introducing an antiseptic either by ejaculatory duct catheterization or by picking up the vas in the scrotum and injecting its lumen by means of a cannula—would effect a cure. Of these methods catheterization of the ducts is difficult and often impossible in spite of the invention of many ingenious devices to facilitate the manoeuvre. The method of vas puncture is not so difficult but injury to the vas causing obliteration or stricture may result however in whatever manner the vesicular cavities are approached unpleasant sequelæ such as epididymitis or vaginal injuries may occur. Again the opening of the vas has the disadvantage that re-injection on more than a limited number of occasions is impossible and a single application of the drug will rarely effect a cure. Further whilst catheterization of the ducts can be repeated theoretically as often as necessary the difficulty often overcomes the advantage. These methods should therefore only be applied when all other means have failed and then only with the greatest care.

### EPIDIDYMITIS

**Ætiology**—This disease often occurs in middle life and may involve the whole or part of the organ and may be either acute or chronic. Although metastatic infections of the epididymis occur the disease is usually secondary to a near by infection such as posterior urethritis, prostatitis or vesiculitis. Whilst gonococcal and tubercular infections account for a considerable number of cases other organisms are often responsible and *B. coli*, streptococci and staphylococci etc. may be isolated on occasions and in cases of metastatic invasion the responsible microbe from the distant focus may be found.

Metastatic infection may involve any part of the organ whilst the usual site for infection derived from the posterior urethra is the lower pole or globus minor.

It is noteworthy that infection from the pelvic organs frequently follows some manipulation either prostatic massage or the passage of urethral instruments. In this respect individuals differ greatly and while some seem to be practically immune others appear to suffer from attacks of epididymitis on the slightest provocation. The greatest gentleness should therefore always be observed during every manipulation though even extreme care may fail to prevent a breakdown. Nor are such occurrences always the result of active interference for many cases have been noted during attacks of prostatitis etc. in which no interference has been practised.

Many experiments have been carried out to determine the route by which organisms pass from the prostate to the epididymis but a clear explanation has not yet been reached. We have already seen that in most infections of the prostate the vesicles are involved so that in the majority of cases germs are actually present in the interior of the genital passages. A controversy has occurred as to whether the microbes reach the epididymis by way of the lumen of the vas or spread thereto by way of the lymphatics of the spermatic cord. Experiments by Kenneth Walker and others suggested that the lymphatics were responsible. On the other hand certain injection experiments by Rolnick (1928) and other workers have shown that it is impossible to inject fluids backwards along the vas beyond the globus minor of the epididymis. Moreover urine has sometimes been observed to regurgitate from the vas when it has been opened. It would appear therefore that as the globus minor is most often attacked and as germs may be carried as far as this site in the urine infection by way of the lumen does occur. The whole question is however as yet undecided.

Chronic pyogenic epididymitis may follow acute invasion or may arise gradually often with an insidious onset and the epididymitis may be the first sign that there is a mild infection of the prostate and vesicles. All the usual organisms may be responsible for these infections which may become so chronic as to simulate tuberculosis.

### SYMPTOMS AND SIGNS

The onset of epididymitis may be sudden, acute and frequently occurs during the course of a general genito urinary infection of which it may be the primary feature. The temperature rises, there is usually considerable malaise and the patient becomes suddenly aware of acute discomfort in one or other testicle—often the left. There may also be a slight urethral discharge. Some cases exhibit tenderness of the spermatic cord or epididymis as a prodromal symptom for a day or two before any apparent lesion appears in the organ.

itself and the first complaint may be of a pain in the groin which extends gradually along the cord into the scrotum. The discomfort is noticed to be increased by physical effort such as walking, stooping, straining, defecation etc. and as in other genito-urinary infections a pain in the back is often a prominent symptom.

The tenderness of the epididymis is sometimes extremely acute and the organ soon becomes definitely swollen usually at the lower pole or globus minor where it receives the infection from the vas deferens. If however the disease is metastatic in origin any part of the organ may be affected.

The inflammation soon spreads beyond the epididymis to the tunica vaginalis and the tissues of the scrotum on the side in which the infected organ lies. The swelling may increase to the size of an orange or larger the skin reddens, becomes glazed and dusky red, loses its rugose appearance and is exquisitely tender. Sometimes areas of softening develop and abscesses occur. A small hydrocele may be noticed early in the onset of the infection.

In a mild case the onset may not be so pronounced the swelling of the epididymis being only discovered on routine examination.

**Course and complications.**—Usually the inflammation of the epididymis subsides more or less gradually and all traces of the disturbance may disappear leaving a healthy functioning organ. In many instances however a residual nodule of scar tissue remains and the resulting contraction may obliterate the delicate tubules and cause sterility. Occasionally these pyogenic infections become chronic. About 25 per cent of cases of chronic epididymitis fail to reveal the tubercle bacillus which is the common cause.

As a rule the body of the testis is not severely implicated but in the late stages scarring and contraction together with some inflammatory disturbance may materially compromise the normal function of the organ. Occasionally the testis may become involved in the inflammation of the epididymis which may spread through the tunica albuginea or pass from one organ to the other by way of the tubules connecting the two. If the testis is heavily attacked its vascularity is impeded the whole organ becomes purulent with sinus formation and more or less complete destruction results. If both organs are so implicated absolute sterility will ensue. As a rule however inflammation commencing in the globus minor spreads slowly only by way of the peritubular tissues and the lymphatics to the body and globus major and the actual body of the testis escapes severe damage.

Cyst formation in the epididymis may follow blocking by scar tissue of the tiny tubules of which the organ is composed and many such cysts may owe their origin to an earlier attack of epididymitis.

**Diagnosis.**—The diagnosis of epididymitis is usually obvious but in the prodromal stage before the organ is acutely involved there may be some doubt. A feeling of weight in the testicle or tenderness along the spermatic cord which may be noticed for a considerable interval before the actual lesion develops should raise an immediate suspicion of what is likely to occur. Sometimes the pain along the upper part of the spermatic cord may suggest appendicitis if the right side is involved but as a rule the site of tenderness is too low for the appendix and the abdomen rarely exhibits any other signs.

The next point which has to be determined is whether the epididymis or the body of the testicle is primarily attacked and if the former which part of it exhibits the maximum signs.

In acute case if the infection is severe the suddenness of onset in a young subject may suggest the occurrence of torsion of the testis and the differentiation between that and inflammation may be difficult. Torsion is however

a strangulation, and whilst elevation of the scrotum in a sling will relieve inflammatory congestion it has little or no effect on a twisted testis, and may be a sign of some value in distinguishing between the two conditions.

If the inflammation becomes chronic and the epididymis is indurated, it may occasionally be difficult to discriminate between pyogenic and tubercular involvement especially if both epididymis and testis are matted together into an inflammatory mass obscuring the origin of the infection, and it may be impossible to be sure of where the infection commenced without exposing the organ by scrotal incision.

As a rule the irregularities caused by pyogenic infections are less prominent than those developed in tuberculosis, and the primary prostatic and vesicular lesions also tend to be less marked. So that prolongation of the case for two or more months' duration with pronounced lesions in the prostate and vesicles, bilateral infection and sinus formation are all suggestive that the case is of tubercular origin. The discovery of tubercular lesions elsewhere will go far to establish a true diagnosis, and the patient's reaction to tuberculin should always be ascertained. Every case must, however, be judged on its individual merits, and sometimes only prolonged and careful observation will make the position clear.

**Treatment**—In acute cases the patient should be put to bed and the usual general routine measures employed. Locally the scrotum should be elevated on a soft pad placed beneath it, or on a sling made of elastic adhesive strapping placed across the upper parts of the thighs. The inflamed area may be painted with belladonna pigment, or hot fomentations may be employed, heat appearing to act more efficiently than cold, though the latter may give relief in some cases. Diathermy by means of an electrode, made hollow to fit the scrotum, sometimes gives great relief and should be tried if the necessary apparatus is available. It may be necessary to give injections of morphia during the most acute stage to relieve the patient's distress. A sharp watch must always be kept for the formation of pus, any collection of which should be opened with as little delay as possible.

In the early stages, before the epididymis is much swollen, suitable serum or hæmotherapy, protein shock, etc., or the latest sulphur preparations have proved extremely useful in checking the severity of an attack. Penicillin should be used when the bacteriology is such as to be influenced by it. Also calcium salts, such as 10 c.c. of a 5 per cent solution of calcium chloride given intravenously, have been used by some who claim that the duration of the illness has been materially shortened thereby.

In some of the most acutely painful cases small incisions may be made through the skin at a few places, and the underlying epididymis may be punctured to relieve the tension. This often gives immediate relief, but is rarely needed and should be reserved for the most acute cases which prove resistant to the usual measures.

Most cases recover in a few days and the organ returns to normal after a longer or shorter interval, the scrotum being supported during convalescence in a suitable suspensory bandage. A few cases, however, become chronically inflamed and remain more or less permanently indurated.

If there is any suspicion of torsion of the cord, the scrotum should be opened to prevent gangrene and destruction of the testis.

In recent years the onset of epididymitis, which is often a troublesome complication after prostatectomy, has been dealt with by bilateral division of the vas deferens as a prophylactic measure, and this has gone far to get rid of the incidence of this annoying phenomenon.

## INFLAMMATIONS OF THE VAS DEFERENS

**Ætiology**—Primary inflammation of the vasa deferentia is an uncommon disease though cases have been reported occasionally in which the lesion in the vas appears to be the only one and which is usually the result of infection by a streptococcus or a staphylococcus. For a case to be a true primary vasitis there must be no inflammation in the epididymis at one end or in the vesicles or prostate at the other and with regard to the latter situation owing to the extremely trivial nature of many vesicular and prostatic infections it is a matter of the greatest difficulty to be certain that they are free from all infection.

Secondary involvements from the vesicles prostate or epididymes are found to be not uncommon lesions if carefully sought for. Occasionally bacteria may pause become lodged in transit and set up inflammatory lesions of the vas and such cases are noticed from time to time during attacks of vesiculitis and epididymitis. Trauma to the spermatic cord may cause the vas to become infected and cases of infected vas have been described after vas ligation puncture or division.

**Symptoms, signs and course**—A local tender swelling with some pain and aching and a nodule of inflammatory thickening appears in the course of the vas. There is usually little disturbance beyond the local manifestations and the lesion tends to subside rapidly and to disappear though in a few instances the whole cord may become involved in a more or less acute inflammation and sometimes if this is opened the vas may be found to be filled with pus. As a rule suppuration occurs rarely and with the subsidence of symptoms the cord returns to normal but occasionally a small residual nodule of thickening remains may cause stenosis and may be the explanation of more cases of obstructive sterility than is generally supposed.

**Diagnosis and treatment**—The diagnosis is easy. Pain tenderness swelling along the cord and the occasional finding of nodules especially if there is an already known infection of the vesicles at once establish the nature of the lesion.

The usual methods of support and local applications will nearly always produce a rapid relief but if the case should go on to more severe manifestations incision and drainage may be required.

## ORCHITIS

**Ætiology**—Orchitis is nearly always secondary to some existing infection and occurs at all ages. Most frequently it is a metastatic lesion and some times affects both organs simultaneously. It is less common than epididymitis and is usually derived from the blood stream during the course of acute fevers or less often by an extension from a near by epididymitis.

Orchitis has been described as occurring during many of the acute exanthemata such as mumps typhoid typhus scarlet fever smallpox measles influenza etc (Morson 1942) and occasional cases have been noted during epidemics of the common cold as well as resulting from metastases from the usual foci of infection. Of all these mumps is the most common and the best known cause. 18 per cent of cases of mumps develop orchitis and it is noticed in such that the right testicle is rather more frequently attacked than the left. A few cases of primary testicular mumps are on record occurring at the specified incubation period no parotid lesion being discovered.

In some cases of epididymitis the inflammation spreads back to the testis either by the region through which the spermatic tubules pass from one organ to the other or by way of the lymphatic network which surrounds the organ.

Trauma is another cause of orchitis but owing to the high mobility of the testis it usually escapes severe injury though crushes bruises and penetrating wounds occur occasionally and may become septic.

**Symptoms and signs**—These are pain and tenderness in the scrotum which may be of an excruciating character may radiate along the spermatic cord into the groin and be felt in the back or lower abdomen occasionally the abdominal function may be sufficiently disturbed as to suggest the onset of acute abdominal sepsis. The testis becomes swollen and exquisitely tender owing to the high pressure set up by the products of inflammation within the unyielding sheath of the tunica albuginea. Sometimes the inflammation may spread through the tunica albuginea and involve the scrotal tissues which become red and slightly œdematous a small hydrocele of 1 to 2 oz. in amount often collecting in the early stages.

If the scrotum is opened it will be found on direct inspection that the testis is a somewhat deeper blue than usual due to the blood engorgement seen through the white glistening albuginea which may be studded with punctiform hæmorrhages as described by Bierberbach and Vibber (1933).

**Course and complications**—The congestion set up by the septic exudates etc. inside the fibrous sheath of the testis greatly raises the pressure within the organ and unless this tension can be relieved at a reasonably early period subsequent destruction and atrophy of the delicate testicular substance is more than likely to ensue. Agam fibrosis and contraction after inflammation which although not so immediately destructive as the initial acute lesions may ultimately obliterate the sperm bearing elements.

Single or multiple abscess formation within the testis is rare and only a few cases are recorded (Mathe 1935). It may follow a general disintegration extending from a purulent epididymitis but occurs most frequently in the course of acute fevers. If an acutely inflamed and purulent testicle adheres to the skin of the scrotum the latter may slough and the testis may be extruded.

Death has rarely if ever occurred as the result of orchitis itself though the disease from which it is derived may be fatal. The chief danger is atrophy of the testicle which owing to the high incidence of orchitis in mumps has been thought by some to account for many cases of sterility and to be more common than is usually supposed. Perhaps some cases of small atrophic testes seen in later life may be the result of some such long forgotten orchitis.

**Diagnosis**—This is determined by local palpation of the scrotum and the discovery of an acutely swollen testis the epididymis remaining relatively unaffected. Cases of acute testicular torsion may be easily mistaken for orchitis and it may be impossible to differentiate between them. The onset of torsion however usually occurs without warning and perhaps after some slight physical effort in an otherwise healthy young subject. In cases of inflammation elevation of the testicle may give relief whilst torsion cases remain unaffected also true orchitis usually causes some toxic symptoms.

As a rule however the local state of the testis reveals the nature of the case unless the condition is masked by a hydrocele with a wall of such thickness that tapping will not allow accurate testicular palpation.

If after careful consideration of all the facts and a close scrutiny of the condition of the scrotum any doubt remains as to the exact condition it is best to incise the scrotum so that there may be no danger of a case of torsion being overlooked with the risk of subsequent atrophy. Cases of partial



torsion with correspondingly mild symptoms may be extremely difficult to elucidate

A word must be added concerning the so called "traumatic" orchitis. After a severe blow on the testes there may be an appearance of an acute infection with swelling and tenderness although no inflammation is present. In the early stages there may be profound shock, which is occasionally fatal. The apparent septic effects are due to hemorrhages, single or multiple, these, by rapidly raising the pressure within the sheath of the testis, cause the extremely severe nature of the symptoms but give rise to no evidence of toxic absorption. The pulse may be raised by the shock but the phenomena will remain strictly localized unless the condition is neglected and sepsis should arise subsequently.

**Treatment**—If a definite case of early orchitis is diagnosed it should be treated at first by the use of anodynes, the local application of heat, elevation of the scrotum, etc., exactly on the same lines as when dealing with a case of acute epididymitis. In most cases resolution occurs rapidly in a day or two, but sometimes symptoms persist. In those instances which fail to improve within a reasonable time the scrotum should be opened by a small incision and tiny slits should be made into the tunica albuginea to relieve the tension within the testis. The incisions in the covering of the testis should be limited and closed by single catgut sutures, to avoid any risk of hernia of the testicular substance, which is, however, less likely in inflammatory cases owing to the matting of the tissues by the inflammation. In all cases of infection of the testis careful watch should be kept for the formation of pus, which should be evacuated promptly.

H L ATTWATER

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## CHAPTER LXIV

### INFLAMMATION OF THE TUNICA VAGINALIS ; HYDROCELE ; HÆMATOCELE

#### INFLAMMATION OF THE TUNICA VAGINALIS

**ÆTIOLOGY**—The tunica vaginalis like the other serous membranes has a visceral and a parietal layer and is lined by a flattened epithelium having a subserous layer of connective tissue in which are lymphatics blood vessels and nerves. It possesses the lowest rate of absorption of all the serous membranes a property which contributes towards the collection of fluid within its cavity under various conditions. Whilst the visceral layer forms a close investment for the testicle the epididymis and the commencement of the vas deferens the parietal layer which is closely applied to it externally forms the serous sac the whole lying within the loose areolar tissue of the scrotum.

The tunica vaginalis is prone to be attacked by all such septic processes as epididymitis vasitis and orchitis by septic conditions of the scrotal integuments or by penetrating wounds. Also it is one of the serous membranes of the body and is liable to be involved in any of the diseases which attack those particular membranes (serositis).

**Symptoms, signs and course**—The inflammatory symptoms are pain and swelling and are usually impossible to separate from those caused by the inflammation of the organs in the immediate vicinity. Also as the tunica vaginalis is derived from the general peritoneum and is similarly innervated in addition to the local swelling pain and tenderness symptoms may be referred to the abdomen and sometimes suggest the presence of an abdominal lesion.

Owing to the inflammatory exudation and the retardation of absorption fluid often collects within the cavity of the sac and forms a hydrocele. These hydroceles being initially of septic origin may remain serous become purulent and form abscesses or pass into a chronic stage when infiltration and thickening of their walls may occur as time passes. In extremely chronic cases the walls have been found to contain plaques of hyaline induration and calcification. Adhesions may also occur between the parietal and visceral layers causing loculation and much irregularity of the cavity. Masses of debris formed of degenerate pus or epithelial cells fibrin or bits of necrotic tissue may be formed and cause nodules in any part of the tunica vaginalis often embedded in the visceral layer over the epididymis or lying loose within the cavity. Scarring and matting of inflammatory fibrosis over the surface of the epididymis and testis may set up pressure effects and lead to the obstruction of the seminal tubules and even to atrophy of the testis.

**Diagnosis and treatment**—Pain swelling and the discovery of fluid surrounding the testicle and epididymis are sufficient evidence of an inflammation of the tunica vaginalis but as it shares in the inflammation of any of the neighbouring viscera epididymis testis etc. it is impossible to distinguish its inflamed condition from that of its neighbours.

Treatment in the acute cases should be directed towards the underlying causes. In chronic cases with thickening of the sac the deposition of fibrous

masses etc., treatment may need to be surgical, as pointed out by Lopez (1929) and many other authorities. The fibrous formation should be dissected away as far as possible, the contents of the cavity should be evacuated and the thickened wall of the sac should be removed on the same lines as when dealing with the hypertrophied sac of an ordinary hydrocele.

**Hydrocele of infective origin**—It has been noted already that any inflammation which affects the serous layer of the tunica vaginalis may diminish the normal rate of the absorption of the fluid and lead to its accumulation. The amount, though usually small, can be demonstrated in many cases, if carefully sought for and may be anticipated in any case of epididymitis, orchitis etc. Torsion of the testis and more rarely strangulation of the embryological remnants—the so-called hydatids of Morgagni—may also be attended by the presence of small hydroceles.

If the infection, which is the cause of the hydrocele, comes from a distant focus by metastasis, as may occur in the course of acute fevers or local septic foci, the causative organism can occasionally be demonstrated in the fluid of the hydrocele.

Epidemics of hydrocele have been reported from the tropics from time to time and the condition may also follow infected wounds of the scrotum.

**Symptoms, signs and course**—The patient usually complains of the sudden onset of tenderness and pain in the scrotum, perhaps sharp in character, or he may describe a sensation of "something giving way" at the commencement of the attack. On examination of the side of the scrotum involved, it will be found to be enlarged, and careful palpation may reveal the presence of a small collection of fluid. Often such a hydrocele is painless and usually contains less than 100 c.c. of fluid, though larger amounts have been noted occasionally and may rarely be sufficient to push upwards along the spermatic cord. Though both organs may be affected simultaneously the condition is most often unilateral and is frequently observed on the left side. Slight oedema of the scrotal integuments, and also of the penis, may be noted, the tissues being thickened and somewhat boggy in character.

Pathologically the infection first causes inflammation of the serous surfaces, which become red, the subserous coats become involved, and the two layers of the sac may become adherent to each other and to the tissues and skin of the scrotum. If the hydrocele becomes converted into an abscess cavity, the pus may burst through the adherent areas and either lead to spontaneous cure or to the formation of sinuses.

The fluid produced in acute hydroceles may be either serous, fibrinous or purulent. Analysis of such a serous collection in the early stages reveals a clear amber fluid having a specific gravity of 1020 to 1025, and containing 4 to 6 per cent. of albumen, some fibrinogen, a little cholesterol and perhaps a small amount of glucose. The fluid differs little from the usual contents of a chronic hydrocele. Inflammation, however, rapidly leads to its turbidity owing to the presence of bacteria, pus, epithelial cells, etc. Red cells may be present occasionally and may be sufficient to cause visible blood staining of the fluid.

These small hydroceles usually disappear as the causative lesion subsides and leave no trace of their presence, but in some 10 to 20 per cent. of cases they become chronic and may cause thickening of the sac of the hydrocele as time passes making accurate investigation of the testis and epididymis by palpation difficult. They are liable to occasional acute or subacute attacks of inflammation which may lead to loculation, sinus formation, etc.

is too forceful or too prolonged from instrumentation per urethram from injuries sustained during surgical operations Infection of the bladder may also result from a variety of operations on the pelvic organs for example in repair of the pelvic floor hysterectomy and excision of the rectum

**CHANGES IN THE BLADDER WALL** as from generalized sclerosis growths and diverticula all tend to encourage cystitis either by lowering tissue resistance by giving rise to residual urine or by causing a breach in the vesical mucosa Alterations in the bladder wall also play a part in cases with lesions of the nervous system which have led to paralysis of the vesical musculature

**FOREIGN BODIES**—Vesical calculi and objects which have been introduced per urethram or by some other route encourage infection by ways other than the production of trauma

**Determining causes**—**THE BACTERIA**—The causal organisms are numerous but the coliform bacillus is the most important It is the commonest it persists for the longest time and is the most difficult to get rid of In their order of frequency the other more important ones may be arranged as follows staphylococcus proteus bacillus streptococcus and the gonococcus

Rarer organisms are typhosus bacillus diplococcus of Frankel diplococcus of Friedlander pyocyaneus other undetermined bacilli and the micrococcus ureæ

These different organisms can exist alone or several be present together On the other hand they can vary according to the stage that the cystitis has reached the original organisms giving place to others in due course If however repeated observations are made on a series of cases a variety of findings may be revealed as follows —

The colon bacillus persists throughout with a considerable variation in the flora caused by other bacteria the colon bacillus is entirely replaced by other bacteria again the colon bacillus after being entirely excluded by other bacteria returns at a later period In contrast with the behaviour of the colon bacillus is that of the streptococcus this organism after appearing in the bladder urine tends to disappear spontaneously As for the staphylococcus it tends to come and go apparently in a struggle with other organisms Pyocyaneus on the other hand has the capacity to overwhelm other organisms and to remain in sole occupation for a period Finally it may be said that the state of the flora is more unstable in the early than in the later stages of an infection

Cystitis is quite independent of the reaction of the urine because in infections with colon bacilli gonococci or organisms which do not decompose urea the reaction is acid and in infections due to urea splitting organisms the urine is sometimes acid and sometimes alkaline It is not possible to know what types of organisms are present merely from observations on the clinical features of a case

**NEIGHBOURING INFECTIVE FOCI**—In both sexes it may be said briefly that foci of infection in the genital organs or the urethra are the commonest causes of cystitis Often the initiating lesion is quite inconspicuous and must be sought for with care The cervix in the female (Fig 339) the prostate and seminal vesicles in the male and the posterior urethra in both sexes are constantly in evidence as localities which harbour foci which are associated with cystitis

Urethroscopy in both males and females who have suffered from cystitis shows chronic foci of infection very commonly indeed in the posterior urethra In the female—in whom cystitis occurs much more frequently than in the male—these appear as granulomata in the form of hillocks or polypi commonly

distributed at any point of circumference in the posterior urethra and generally in the vicinity of the internal urinary meatus (Figs 346 to 358)

In the male the inflammatory changes in the posterior urethra are commonly seen to involve the prostatic sinuses the verumontanum in addition to changes nearer to the internal urinary meatus. Chronic inflammatory conditions involving the more anterior parts of the urethra and even the vulva or preputial sac play an equally important part in predisposing to cystitis.

Whether the urethral infection is primarily an acute one or a chronic one which has become acute the inflammation quickly involves the whole bladder if acute cystitis occurs. In the chronic form however any extent of infection may be present from the whole bladder to a small area on the front of the trigone.

**Routes of Invasion.**—The blood stream undoubtedly carries infection to the bladder in the course of such general infections as influenza and typhoid fever.

Via the lymphatics from the internal genitals or the urethra. My own experimental work suggests this. Infection of the uterine cervix or vagina must be considered foci of infection which commonly involve the bladder.

The pelvic cellular tissue often becomes widely infected from some adjacent focus and cystitis can arise from this source. Experimentally the injection of micro-organisms into the extraperitoneal tissue also produces cystitis.

Both experimentally and clinically it has been proved that infection can spread from the rectum to the bladder. I have noticed the rapid onset of cystitis following the injection of hemorrhoids with carbolic acid. Cuturi (1910) has proved experimentally that tuberculosis passes from the rectum to the bladder by way of the lymphatics.

**FROM THE URETHRA.**—This is a common route by which invasion occurs. In order for infection of the bladder from the urethra to take place it is not sufficient that organisms merely are present in the urethra for they exist here normally. These can even be carried into the bladder on instruments passed per urethram without causing cystitis. It is true however that organisms introduced into the bladder on an instrument can cause cystitis, but the onset of inflammation in these circumstances is probably due to the fact that they have a greater virulence than those habitually resident in the urethra or that trauma has occurred.

In the female the short urethra opening into an area which constantly harbours organisms undoubtedly has a bearing on the greater prevalence of

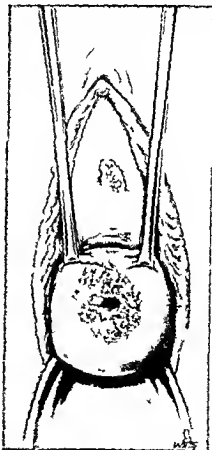


FIG 339

Cervical erosion and granuloma at external urinary meatus in a patient aged 49 who also suffered from chronic cystitis.

cystitis in this sex. The latter condition occurs much more commonly without catheter insertion in the female than in the male.

Cystitis following instrumentation does not necessarily mean that the organisms have been introduced in this way. A commoner cause is the stirring up of infection already existing—often in a latent form—in the posterior urethra, the prostate or at the internal urinary meatus.

FROM THE URETER—When the kidney becomes infected from the blood stream there seem to be special opportunities for the bladder also to become inflamed from the organisms carried there by the urine. But there is a difference of opinion as to whether this commonly occurs. It is a sound view that this method of causing cystitis is unusual and that it is unlikely to occur unless some state of the bladder exists which predisposes it to infection. Certainly experimentally it has been repeatedly shown that organisms of different kinds injected into the blood stream usually pass through the bladder without setting up inflammation. The higher hydrogen ion concentrations of the urine which tend to be bactericidal probably play a part in discouraging the onset of cystitis from organisms which may chance to be present, but in contrast with this fact bacteria can proliferate in the urine without setting up cystitis.

The bladder commonly becomes infected from the ureter by an extension of the inflammatory process from the wall of the ureter directly to the bladder. The most striking example of this process occurs in connection with tuberculosis.

AS A RESULT OF SOLUTION OF CONTINUITY OF THE BLADDER WALL—This may occur in such conditions as vesico intestinal fistula, tubo vesical fistula and appendiculo vesical fistula. But here as in connection with the ureter if the bladder is not in the state of a soil prepared to receive the seed the organisms will pass harmlessly through.

### PATHOLOGICAL ANATOMY

**Acute cystitis—MACROSCOPICAL APPEARANCES**—The infection generally involves the whole extent of the vesical surface. Sometimes one sees the inflammation limited to a small part of the bladder, especially is this the case when the inflammation has spread from a focus adjacent to the bladder.

It is as a result of CYSTOSCOPY more particularly that macroscopic changes have been studied. By this means it is possible to identify fairly clearly the different lesions according to the intensity of the cystitis. Some of these are constant and others are present only in certain cases making it possible to establish the relationship between the condition of the bladder and the clinical features of the case.

Congestion is always present and shows itself in the initial stages by the number and size of the blood vessels visible in the mucosa.

A further advance leads to a generalized redness of the mucosa as the next stage. The latter change is accompanied by a thickening of the mucosa which is apparent through the cystoscope as a loss of capacity to expand as a result of the distension so that the mucosa appears in folds instead of being smooth showing the presence of prominences and recesses. When the entire bladder wall takes part in the inflammation the condition produced is called interstitial cystitis and there is a consequent thickening of all coats of the bladder.

There are other changes which are variable. bullous oedema appears as reddish rounded semi translucent elevations projecting from the surface of the mucosa as the condition tends to disappear the bullae shrink into small

scattered vesicles—sometimes instead of vesicles there are pustules which are in fact subepithelial abscesses. These pustules after rupturing show small ulcerating areas of different sizes and depth. An abscess may form in the bladder wall in connection with cystitis at any depth and when such abscesses rupture into the bladder they give rise to areas of ulceration which necessarily vary in appearance. Sometimes the ulcerated area is surrounded by œdema. Such a lesion may easily be mistaken for a neoplasm.

In certain cases of prolonged cystitis proliferating granulations which bleed easily may be observed. In other cases small subepithelial hæmorrhages are to be seen as bright red patches. On the surface of the mucous membrane fibrinous purulent or pseudomembranous exudates are sometimes seen.

**MICROSCOPICAL APPEARANCES**—In the early phase of acute cystitis the opportunities for histological investigation have necessarily been limited. Information on this subject has been obtained from pieces of tissue removed from the bladder wall during operations, the necessity for which rarely occurs.

In the early stages there is dilatation of capillaries, migration of leucocytes, infiltration of cellular tissue with lymph and white cells, but the epithelium remains intact.

In a further stage the epithelium desquamates as the infiltration of the underlying tissue increases. This process may go on to abscess formation in a single locality or may involve a wide area. The purulent process may be located in any of the layers of the bladder wall.

In some cases the mucous membrane may be covered with a false membrane which consists largely of fibrin with entangled pus and epithelial cells. In the more severe cases pieces of slough from the bladder wall are included in the membrane.

In more severe cases still the whole of the vesical mucosa—sometimes even the muscular coat—is encroached upon, making the condition a **GANGRENOUS CYSTITIS**. This results in a slough representing a mould of the vesical cavity and made up of the different layers of the bladder wall—mucous, submucous and muscular, which to some extent have become separated from each other and infiltrated with newly formed connective tissue cells, with only occasional leucocytes, the normal tissues appearing to be in a process of degeneration. Once this slough is extruded the interior of the bladder is formed by the muscular wall and it is possible for the patient to recover, the exposed surface in due course becoming covered with scar tissue and epithelium with a consequent loss of elasticity of the vesical wall.

**Chronic cystitis**—As a rule chronic cystitis ultimately involves all the coats of the bladder with a resulting increase in thickness which may amount to several centimetres. This generally results in a loss of bladder capacity and a lessening of the power to expel the urine. The bladder tends thus to become somewhat fixed. The latter change is sometimes apparent when the bladder is opened above the pubis.

**THE MUCOSA**—Often the full extent of this coat is involved although the inflammation may be localized to the bladder base. The colour becomes reddish but of a less intensity than that of acute cystitis.

At first there is partial *desquamation of epithelium*, but with time the whole depth of this structure may disappear. In the early stages the infiltration of the submucosa with round cells is replaced by *fibrous tissue* which tends to obliterate blood vessels.

In old standing cases of *granular cystitis* at certain places the surface instead of being smooth becomes crinkled like morocco leather or there may be actual vegetations which are small or large sessile or filamentous.

projections which may then be described as *vegetant cystitis*. The proliferations are composed of cellular tissue infiltrated with round cells and capillary loops which have their origin in new vascular formations in the submucosa.

*Hæmorrhages* into the core of the granulation are common and explain the bleeding which occurs in this type of cystitis.

*Abscesses* occur and give rise to ulceration when they rupture but these may be seated at any depth in the bladder wall and be responsible for sclerosis in due course. As in acute cystitis necrosis with *sloughing* may supervene. When such a slough is superficial it is called a false membrane.

*Calcareous deposits* may occur on ulcerated areas and give rise to the condition known as *incrusted cystitis*. The deep surface of the crust consists of necrosed tissue which becomes less as the phosphatic deposit becomes more abundant towards the free surface. Deep to the plaque is a zone of cellular tissue with colonies of organisms and *thrombosed vessels*. deeper still is the submucous or muscular coat which is infiltrated or sclerosed.

Inflammatory lesions of the epithelium can in due course give rise to *cystic cystitis* and to gland like structures which warrant the term *glandular cystitis*. The cysts are generally about the size of millet seed but may be larger. In due course they may be replaced by smooth patches of epithelium. They occur most commonly on the trigone but may appear on the mucous surface of any part of the urinary tract. Microscopically the epithelium is found to be normal in places and in others to have suffered superficial desquamation. In the deeper part isolated areas of epithelium are seen some of which are cystic and contain clear or yellow fluid.

*Glandular cystitis* is characterized by invaginations of epithelium into the mucous and submucous tissues. It is met with in all parts of the bladder. The crypts which are so formed may penetrate as deeply as the muscular coat. Some of these structures appear to be entirely separated from the epithelial surface. They contain a homogeneous substance mixed with desquamated epithelial cells. The cells of the glands appear to have taken on the functions of mucous secreting glands which are tubular or racemose and some of them open by excretory canals on to the surface of the epithelium.

It seems that the method of formation of the two varieties of cystitis—*glandular* and *cystic*—is the same the difference arising from the transformation of vesical epithelium into mucous cells.

Another change is that the epithelium becomes thickened and stratified forming smooth bluish white plaques of *leucoplakia*. These are always multiple and may involve any part of the mucosa of the urinary tract. These various lesions of cystitis can occur in bladders previously healthy or they occur in bladders already the seat of disease so that other lesions exist with them.

**SUBMUCOSA**—This coat presents the well known changes of inflammation according to the proximity and the stage of the inflammatory process proceeding ultimately to resolution or pus formation and sclerosis. In *glandular* and *cystic* cystitis clumps of mucous secreting glands appear and give rise to cysts which form projections on the mucous surface.

**MUSCULAR COAT**—In the earlier stages of inflammation there is hypertrophy. In the more chronic cases this is succeeded by fibrosis. The eventual invasion of this coat by fibrous tissue results in muscular atrophy and consequent impairment of function. Crypts resulting from *glandular cystitis* sometimes penetrate as deeply as this coat.

**PERIVESICAL CELLULAR TISSUE**—In long continued cystitis this coat is inevitably attacked. It results in fibro fatty adhesions between the bladder



and adjacent structures and may result in a considerable extra thickness being added to the bladder wall.

When the fibrous rather than the fatty tissue predominates the bladder wall becomes largely fixed and incapable of distension. Alternatively there may be pericystitis with localized or diffuse abscess formation.

All the vessels and nerves in the area are involved in the fibrosis as shown by the invasion of at least their outer coats by fibrous tissue.

### SYMPTOMS AND SIGNS

Although these are often more intense in acute than in chronic cystitis yet there are certain cases of chronic cystitis which cede nothing in this respect to the more acute ones. In these circumstances there is no important object in trying to deal with the two classes of cases separately. There are four principal symptoms: pain, frequency, pyuria and hematuria.

Pain is acute in proportion to the severity of the cystitis. In the mildest cases it may be almost absent. It begins just before micturition starts and the urge to micturate expresses itself as a painful sensation. This exists throughout micturition and is aggravated as the act finishes, sometimes producing a tenesmus which is rectal as well as vesical. The patient may assume abnormal positions while the pain is at its height. The pain often persists after micturition is finished and creates the impression that the bladder is not empty and provokes further contraction of the abdominal muscles. Between the acts of micturition there is sometimes a generalized discomfort in the pubic and suprapubic regions, in the anus, the perineum and along the penis.

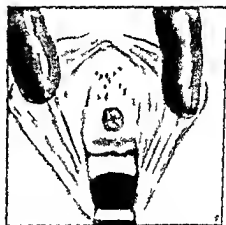


FIG. 340

Prolapse of urethra and mild prolapse of rectum in a patient aged 64 with trigonitis and urethral polyp (retrotrigonitis). The prolapse is a result of chronic frequency of micturition.

Frequency of micturition is more pronounced in the day than during the night and is present in proportion to the intensity of the cystitis. The urge to micturate may occur every few minutes or at intervals of an hour or more; this may result in urethral prolapse (Fig. 340). In the worst cases the desire to micturate may be so incessant giving the patient literally no rest. The desire to pass water may be so marked as to amount to incontinence. Recumbency does not necessarily ease the frequency; in fact it may make it worse.

There is no doubt that the frequency of micturition is often exaggerated by polyuria, which the cystitis produces by its action on the kidney. The relationship is apparent from the fact that the polyuria lessens as the cystitis subsides. Other influences may cause the frequency to vary from day to day.

**Pyuria.**—Except in certain cases of anterior trigonitis pyuria is never absent. It varies with the intensity of the cystitis. It may be very slight, producing only a suspicion of cloudiness of the urine, or it may be so marked as to render the urine completely turbid, which soon forms a deposit on standing. When the urine is passed into three glasses the turbidity is at its maximum.

in the third one. Except when cystitis is accompanied by abscess formation, the quantity of pus is not so copious as often comes from the kidney in pyelonephritis.

**Hæmaturia** is not constant though frequently to be noted. Usually there are present only a few pieces of blood-stained debris in the urine or a few drops of blood are expressed at the end of micturition. On the other hand, the whole specimen of urine may be deeply stained with blood. Bleeding may be sufficiently prominent to justify the term "hæmorrhagic cystitis," which is seen sometimes in bad cases of cystitis with gonorrhœa and in acute cases due to the colon bacillus. In bad cases the most gentle intervention with a catheter or vesical irrigation may produce this symptom.

Debris of different kinds may appear in the urine—fibrin, false membrane, small sloughs, phosphatic sand or gravel. Incrusted cystitis may cause the presence of phosphatic debris in the urine to be a prominent feature. As a result of decomposition of sloughs the urine may develop an extremely offensive odour, this is encountered in particular in the presence of new growths.

**Retention of urine** as a direct result of the cystitis may manifest itself either as complete or as incomplete retention.

**INCOMPLETE RETENTION** is demonstrable in finding varying quantities of residual urine on catheterization, even though there is no appreciable obstacle to micturition and may be due to a reflex interference with vesical contraction towards the end of the act of micturition, in fact, at the moment when the pain accompanying micturition reaches its maximum. The lack of resiliency of the bladder wall due to cystitis, may also be a cause of retention.

**COMPLETE RETENTION** can be produced in the same reflex way, but is generally due to an associated obstruction either at the bladder neck or in the urethra. Whether the retention is complete or incomplete failure to empty the bladder of infected urine undoubtedly encourages a further degree of infection which may manifest itself in the onset of further infective complications.

The general condition of the patient may become very bad as a result of cystitis especially from want of sleep from the pain and frequency of micturition. It is important to remember that the onset of fever with cystitis means that some infective complication has supervened, perhaps of the kidneys, the prostate or the perivesical tissues, or it may be a general systemic infection.

**Palpation and instrumentation**—Vaginal, rectal or suprapubic pressure on the bladder will produce tenderness and a sharp pain can often be elicited at the neck of the bladder if it is pressed against the pubis.

On passing an instrument per urethram pain is usual the moment the posterior urethra is entered. This is because this locality is commonly the seat of inflammation as well as the bladder. This sensitivity is equally noticeable as the instrument passes over the bladder neck and perhaps less so when it comes in contact with other parts of the vesical mucosa. An inflamed bladder is very sensitive to attempts at distension by the injection of fluid and there is a diminution in its capacity as a result. In the worst cases the bladder will retain not more than a few cubic centimetres, it is often to be noted, however that the bladder will hold less of injected fluid than of urine which is allowed to accumulate.

**Cystoscopy**—This examination is quite impossible where the bladder capacity is greatly reduced as a result of the inflammation. This method of examination is essential in due course in all cases of cystitis. The examination is impossible and generally undesirable in bad acute cases and should be carried out only after the acute symptoms have subsided. General, spinal or sacral anaesthesia may be necessary, but often a local anaesthetic will suffice.

Irrigation must be carried out with the greatest gentleness running in the fluid as slowly as possible and taking care not to distend the bladder and not to allow it to empty completely during the washing out process. There is a great variety of changes to be noted by cystoscopy in cystitis.

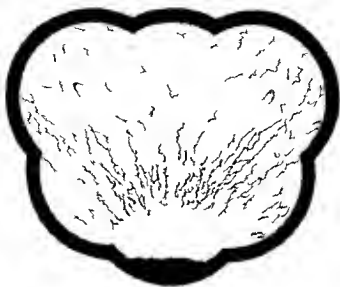


FIG. 341

Cystoscopic view showing inflammatory changes confined to the front of the trigone in a woman aged 29 with urethritron.

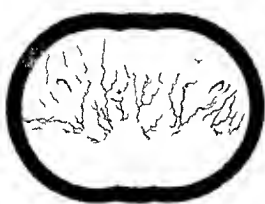


FIG. 342

Cystoscopic view showing marked epithelial hyperplasia of the trigone in a woman aged 19 with urethritron.

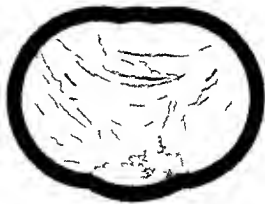


FIG. 343

Cystoscopic view showing chronic granular changes on the front of the trigone in a woman aged 58 with chronic urethritron.

These appearances differ according to the stage that the inflammation has reached, especially in regard to whether it has attained its maximum or whether it is subsiding. The changes may involve the whole or only a part of the bladder. The partial lesions may be not only in the vicinity of the neck (Figs. 341, 342 and 343) but in any other part of the bladder. The knowledge of this fact is of first importance in avoiding confusion between a patch of oedematous cystitis and a new growth.

It is common to find the inflammation localized to the front of the trigone and internal urinary meatus in cases of mild chronic cystitis with little or no pus in the urine. At the internal urinary meatus hillocks or polypi are often to be seen disposed around the circumference (Figs 346-349) and are not unusually accompanied by similar changes in the posterior urethra especially in the female. It is necessary to have the patient in the lithotomy position to examine this locality to the best advantage.

*Congestion* is the commonplace lesion of cystitis. In an early stage it is characterized by an increase in the number and size and the blurred outlines (Fig 132) of the blood vessels which are visible on the mucosa. A further stage is that the mucous surface becomes uniformly red. When the inflammation is very acute there is thickening and loss of extensibility of the bladder wall and the vesical mucosa lies in folds.

Sometimes there are localized inflammatory swellings on a reddened background or in a bladder only slightly inflamed. During the period of



FIG 344  
Cystoscopic view showing cystitis  
with bullae and venous thrombi



FIG 345  
Cystoscopic view showing inflam-  
matory bullae and fibrinous debris  
on the bladder wall

subsidence the redness often disappears in patches so that red and pale areas are to be seen side by side (Fig 132 Nos 8 and 10).

Patches of petechiae are often noted (Fig 372) occasionally thrombi are seen (Fig 344) other lesions may or may not be present with any of the above.

*Edema* generally as a localized area of semi translucent pink bullae (Fig 345). As this condition subsides the cedematous area becomes smaller the bullae shrink in size the colour fades and one sees a few small scattered pinkish nodules.

*Bullous edema* exists not only in conjunction with cystitis but also in relation to neoplasms infiltrating the bladder wall in which case it is due to circulatory changes caused by the growth. It is also seen at a ureteric orifice when a stone is impacted there also when an extravascular growth or inflammatory mass becomes adherent to the bladder wall.

Sometimes congested areas bleed very easily and the loss of blood may actually be seen coming from a number of adjacent points—*haemorrhagic cystitis*.

When simple cystitis gives rise to an abscess in the wall of the bladder a large number of *small yellowish pustules* confined to a reddened area may be seen. Such an appearance may raise the question of tuberculosis. The *abscess* may take the form of a large reddened projection surrounded by edema.

or if the abscess has discharged there may be a centrally placed area of ulceration. The latter appearance may create a difficulty in excluding carcinoma. Sometimes only when the bladder has returned to normal is the diagnosis certain although the rapid course of events if abscess is present should enable one to exclude carcinoma.

*Ulcerations* may occur with a variety of features in cases of simple cystitis. In some appearances may strongly suggest a tuberculous condition and it may not be easy to come to a proper decision on mere cystoscopic examination.

*Inflammatory vegetations* may appear in a variety of forms from small slender filaments to large fleshy projections as a rule they are not difficult to distinguish from papillomatous new growths because of the presence of associated inflammatory manifestations.

*Incrustations* result from ammoniacal decomposition of urine which leaves calcareous deposits adherent to ulcerated surfaces. They appear as whitish or greyish plaques of different sizes. They are generally multiple but a single mass covering an area projecting from the mucosa may simulate a stone. They are not to be confused with masses of pus and other debris which are easily disturbed by lavage nor with patches of leucoplakia which are more or less flush with the surface.

A *strangling portion of a neoplasm* may simulate a simple incrustation. An ulcerated area of a neoplasm may be the seat of an incrustation which conceals the presence of the new growth. Suspicion of something unusual may be aroused if there is a single incrustated area only for an inflammatory state in association with ulceration generally occurs as multiple lesions.

*Masses of fibrinous debris* (Fig. 345) may be sufficiently adherent to the mucous membrane to survive the lavage preparatory to the cystoscopy. Portions of them are sufficiently ragged and light to move about in the fluid and thus to indicate the identity of the mass. Where there is continued doubt as to the nature of a mass repeated and vigorous lavage will generally reveal its nature.

*False membrane* of a gangrenous cystitis is grey in appearance and floats in the fluid.

**Radiography**—Plain X rays of the bladder region may show an area of incrustation as an irregular and mottled zone. When the deposit is dense it may give the impression that a calculus is present.

*Phleboliths* are commonly present in the true pelvis as a result of chronic cystitis.

In cases of chronic cystitis the *cystogram* tends to show an irregular bladder outline.

**Types of cystitis**—The course which cystitis takes varies with the cause and the lesion which supervenes in the bladder. The following are the principal types—

**ACUTE CISTITIS**—There are three straightforward examples of this condition: cystitis complicating gonorrhoea, cystitis following urethral instrumentation, cystitis which develops suddenly and apparently spontaneously.

The symptoms are usually severe and bleeding may be present sometimes in sufficient degree to warrant the term hæmorrhagic cystitis. In due course all the symptoms tend to abate either spontaneously or after suitable treatment.

**SUBACUTE CISTITIS**—The symptoms in this type are less severe than in the acute condition but they are more persistent. Cases of this group are due most commonly in either sex to a chronic focus of infection either in the genitals or the urethra. They frequently have recurring acute attacks.

**CHRONIC CYSTITIS**—In these cases the symptoms go on indefinitely and are kept up by the presence of a chronic focus of infection in the genitals or the urethra or because of the presence of a vesical diverticulum, an unrelieved obstruction a renal infection a urinary stone etc. The chronic course of the symptoms may from time to time be interrupted by acute attacks of infection. At first the cystitis is maintained by one of the causes indicated above, but sooner or later changes in the bladder wall begin to play their part in causing the symptoms to persist and to become more pronounced.

**CHRONIC CYSTITIS WITH ACUTE SYMPTOMS**—In these cases although chronic cystitis is present attacks of pain occur which are as severe as those experienced in the most severe acute cases and continue in spite of regular and orthodox treatment and warrant the designation intractable cystitis.



FIG. 346

Urethroscopic view of the internal urinary meatus. The pressure of the fluid flowing in through the instrument has obliterated all the normal folds of mucous membrane and displays a number of early polypi (hullocks) in a woman with urethro trigonitis.

Although tuberculosis is excluded from this group yet there exist factors which prevent recovery for example enlarged prostate urethral stricture bladder diverticulum etc.

The progress of time inevitably causes changes in the bladder wall which aggravate the existing cystitis such as incrustations abscess sloughs sclerosis cystic and glandular cystitis.

**ANTERIOR TRIGONITIS (urethro trigonitis)**—The existence of the condition as a cause of chronic disturbance of micturition in woman was probably first described by Heymann (1905). This is a common form of cystitis in women. It can be discovered only on cystoscopy and may escape notice because the vesical mucosa is quite free from signs of inflammation except that there is an inflamed area which is confined to a varying extent of the trigone adjacent to the internal urinary meatus (Figs 341 342 and 343). This focus may be so small that it can be easily overlooked unless the patient is cystoscoped in the lithotomy position.

The condition is a common accompaniment of gynaecological disorders and of pregnancy. In most cases the posterior urethra is also the seat of inflammation.

Two hundred cases of anterior trigonitis in which I have carried out urethroscopy showed that the posterior urethra was also the seat of an inflammatory process in 90 per cent. The internal urinary meatus is often also involved in the inflammation (urethro cervico trigonitis). This is not surprising seeing that it lies between the vesical trigone and the posterior urethra. Whether



FIG 347

Urethroscopic view showing multiple polypi, in a woman aged 53 suffering from urethro trigonitis



FIG 348

Urethroscopic view showing polypi with granulomata at base. A close up view of a group of polypi shown in preceding illustration



FIG 349

Urethroscopic view showing polypus in posterior urethra near internal urinary meatus in a woman aged 48 suffering from urethro trigonitis

the bladder condition is a complication of the urethral state is a matter upon which it is difficult to be dogmatic but certain it is that in a large number of cases the bladder symptoms are improved by treating the urethra.

The condition to be noted on cystoscopy is best seen when the trigone is viewed in profile. A variety of changes may be identified: a roughness of the surface, patches of thickened epithelium, superficial ulceration, bulky irregular projections of tissue, hillocks or polypi on the margin of the internal urinary meatus, a granulomatous projection of tissue from the floor of the internal urinary meatus, or small rounded semi-translucent elevations in

due course some of these changes tend to involve the whole of the trigone or there may be a sudden spread of acute inflammation to the whole of the vesical mucosa. If cystoscopy is carried out when the latter circumstances prevail the importance of the bladder neck focus may be obscured.

*The posterior urethra in the presence of anterior trigonitis*—Chronic inflammatory changes in the posterior urethra are exceedingly common in patients who suffer from chronic disturbances of micturition or who are subject to attacks of acute cystitis. In such patients anterior trigonitis is invariably

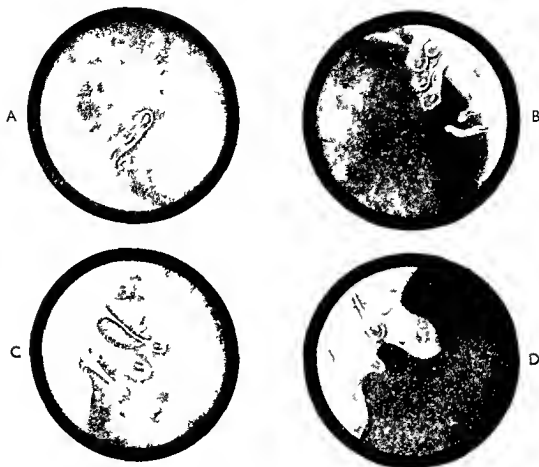


FIG. 350  
Four groups of urethral polyp in a woman aged 34 suffering from urethro trigonitis

present as well (urethro trigonitis). It is especially to women that these facts apply. With the urethroscope any of the following changes are to be seen (Figs 346 to 358)

- 1 Granular patches which are slightly raised granulomatous areas of redness
- 2 Ulcers
- 3 Hillocks in the form of fixed localized prominences projecting from the surface
- 4 Polypi
- 5 Cysts
- 6 A number of pin points oozing pus have been seen as a rare condition



Sometimes there is a generalized contraction of the whole urethra in addition to any of the above changes

*Symptoms and signs*—The most outstanding symptom is chronic frequency of micturition. In the early stages it is more pronounced in the daytime, but in the old standing cases nocturnal frequency becomes a prominent



FIG. 331

Polyp in posterior urethra near internal urinary meatus, in a woman aged 36 suffering from urethro trigonitis



FIG. 332

Urethroscopic view of cysts in the posterior urethra near the internal urinary meatus, in a woman aged 24 suffering from urethro trigonitis and cervical erosion (same case as Fig. 339)

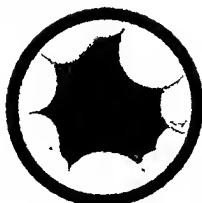


FIG. 333

Urethroscopic view of numerous cysts in the posterior urethra near the internal urinary meatus in a woman aged 40 suffering from urethro trigonitis

feature also. There is often intermittent dysuria, generally terminal in relation to micturition. In well established cases there may be, some delay in passing water, and a few ounces of residual urine. An aching pain in the lower abdomen or pubic region as the bladder fills is not uncommon.

In about 10 per cent of these cases the urine shows no signs of infection, and in the others the scanty evidence that infection is present seems quite out of proportion to the patient's symptoms which in due course, in the more

chronic cases tend to include such constitutional manifestations as headaches, rheumatism nausea or occasional vomiting

**GANGRENOUS CYSTITIS**—This condition does not necessarily give rise to severe symptoms. The outstanding features are a foul urine, difficulty with micturition—even complete retention—and a poor general condition. Because of the presence of partly or completely detached sloughs in the bladder an attempt to relieve retention by catheterization is likely to be unsuccessful.

### COMPLICATIONS

These may arise in any case of cystitis and may have a profound influence on the outcome.

**Ascending infection of the kidneys** is the commonest complication and at once puts a graver aspect on the case. The likelihood and importance of this complication are greater when chronic inflammatory changes involving the lower urinary tract are pronounced, especially when there is an obstructive condition present at the bladder neck or in the urethra.

**Urinary fever** is a grave complication and is most likely to occur in old standing urinary cases.

**Perivesical abscess**—Of local complications this is serious because it is difficult to recognize and to treat. The abscess may open spontaneously into the bladder, but may continue to discharge pus for an indefinite period.

**Gangrene** involving the whole extent of the vesical mucosa and part of the submucous and muscular coats may give rise to a series of complications.

**Retention of urine** is to be expected in the foregoing cases as a result of the impaction of slough at the bladder neck. **Pyelonephritis** is also to be expected, and if it does not arise during the period of cystitis it may supervene later from the obstruction of the ureters caused by the cicatrization in the bladder wall. Finally the capacity of the bladder may be so reduced by cicatrization that incontinence of urine results.

### DIAGNOSIS

This subject may well be considered from two aspects —

- 1 Whether cystitis exists
- 2 The cause of the cystitis

**Whether cystitis exists**—The diagnosis of the existence of cystitis is generally a relatively simple matter, nevertheless confusion may occur, so that true cystitis may be missed, while some other condition may be thought to be cystitis. There are, indeed, other conditions which give rise to the same train of symptoms.

**Prostatitis** gives rise to frequency, urgency, pyuria and a certain amount of discomfort on commencing to pass water. In *gonorrhœa* in particular, these symptoms may give rise to confusion with those due to cystitis.

In prostatitis the symptoms are less pronounced than in cystitis of the same origin, the desire to micturate is more urgent than frequent, the pyuria is not always total but often more obvious at the beginning and the end, the bladder capacity is not reduced, and the prostate is tender on rectal examination.

Attacks of prostatitis might also occur in connection with hypertrophy of the prostate and give rise to the difficulties just discussed. On the other hand, it must not be forgotten that cystitis and prostatitis are often associated.



FIG 354  
Urethroscopic view showing two urethral polypi near the internal urinary meatus, in a woman aged 46, suffering from urethro trigonitis



FIG 355  
Urethroscopic view showing a urethral polypus near the internal urinary meatus in a woman aged 50 suffering from urethro trigonitis.



FIG 356  
Urethroscopic view showing a group of cysts near the internal urinary meatus same case as preceding figure



FIG 357  
A prominent urethral polypus and several less obvious polypi near the internal urinary meatus in a woman aged 46, suffering from urethro trigonitis



FIG 358  
Urethroscopic view showing an unusually long polypus in the urethra of a woman suffering from urethro trigonitis

In women certain affections of the neighbouring organs can cause frequent and painful micturition—tumours and inflammation of the uterus, inflammation of the broad ligament and of the Fallopian tubes, displacements as a result of the stretching of the pelvic floor. The freedom of the urine from pathological elements should cause one to consider the above-mentioned conditions. Chronic inflammatory changes in the urethra in women are worth special mention where granulomata or polypi may be present. Normal urine and a satisfactory bladder capacity eliminate cystitis.

*Neuralgia of the bladder* (cystalgia) is the term commonly applied to a painful condition which sometimes follows cystitis after the pus has disappeared from the urine. In spite of the absence of pus a painstaking bacteriological examination commonly reveals the presence of organisms in the urine, and a careful search by endoscopy of the region of the internal urinary meatus and the posterior urethra will generally reveal a chronic focus of infection. Certainly the fact that the symptoms generally follow cystitis indicates the likelihood that they are caused by an infective condition lurking in the neighbourhood. The term is probably more accurately applied in connection with the vesical pains of tabes and reflex bladder pains associated with painful conditions of the anus.

*Vesical calculus* without cystitis may simulate cystitis, and a puzzling case will call for cystoscopy, which will reveal the true state of affairs.

*Malignant vesical neoplasm* may suggest a condition of cystitis, and uncertainty as to the cause of the symptoms will necessitate a cystoscopic examination.

*Stone in the lower end of the ureter* causes symptoms indistinguishable from those of cystitis, and both cystoscopy and radiography may have to be employed before the diagnosis is certain.

*Certain changes in the urine*—Phosphaturia in particular sometimes causes symptoms closely resembling cystitis. Chemical and microscopical examination of the urine and cystoscopy will make it clear what is the cause of the symptoms.

**The cause of the cystitis**—The diagnosis of the cause of cystitis is particularly important from the point of view of treatment.

The bacteriology must first be fully investigated. Sometimes this line of inquiry will result in the discovery that what was thought to be a simple cystitis is actually tuberculosis.

The cause may be obvious, as with cystitis due to gonorrhoea or after the passage of sounds.

The cause may not be clear. A painstaking search in these circumstances will be necessary. In both sexes the *internal genitals* and the *posterior urethra* are quite commonly the origin of the trouble, and these sources may easily escape notice. Urethroscopy may be necessary to establish the origin of the infection.

In all cases where it seems difficult to establish a cause for the cystitis or where there seems to be an unusual lack of response to treatment *tuberculosis* should be carefully considered and all the necessary tests should be applied to exclude this disease (see Tuberculosis). Quite a number of cases at first thought to be simple cystitis are really tuberculous which have escaped detection because of the lack of characteristic lesions to be observed in the bladder on cystoscopy, and because the proper tests have not been applied.

Except during an acute stage, *cystoscopy* should be carried out in all cases of cystitis. In the female rather than the male *urethroscopy* often proves to

be equally important. This applies particularly to cases where the symptoms of chronic cystitis persist while cystoscopy shows only slight inflammatory changes localized to the neck of the bladder.

Chronic cystitis which has produced oedema is not always easy to distinguish from an infiltrating carcinoma of the bladder. When the change is very localized it is more likely to be due to carcinoma.

Certain cases of abscess of the bladder can also raise the question of carcinoma so much so that it may be by no means easy to decide which condition is present. It may be necessary to remove a piece of tissue with rongeur forceps for microscopic examination before a decision can be made.

*Incrusted cystitis* has to be carefully distinguished from certain neoplasms which present sloughing surfaces. The chief distinguishing feature is that with the incrusted cystitis the lesions are multiple and scattered whereas the neoplastic condition is a single lesion and projects prominently from the surface. Ulceration caused by simple cystitis is not ordinarily difficult to distinguish from tuberculosis.

**Prognosis**—A sudden attack of acute cystitis after a course of a week or so will in most early cases completely subside. In others a state of mild chronic frequency remains. In many cases there is a tendency for the acute attacks to recur sometimes after an interval as long as several years. The more marked the chronicity the greater is the tendency for acute exacerbations to occur.

The best safeguard for a good prognosis is to seek out and deal with the predisposing cause in the early stages of the disease. This cause may be in the upper urinary tract; it may be intravesical or extravescical. The regions which in both sexes most commonly supply the predisposing cause include the internal genitals and the posterior urethra.

It cannot be denied, however, that the longer a case of cystitis has endured the more lasting become the changes in the bladder wall and the more difficult it is to cure the cystitis.

In bad chronic cases there is the danger of a fatal issue from acute infection of already badly damaged kidneys or from a systemic invasion.

**Treatment**—LOCAL SEDATIVE MEASURES directed towards relieving the distressful nature of the symptoms should always take an important place when treatment for cystitis is arranged. Frequent and painful micturition should be the main objectives in this respect. Prolonged hot baths are comforting when these symptoms are pronounced.

In women to whom vesical lavage can so much more easily be given than to men 2 or 3 oz. of a solution of 2 per cent. antipyrine and 1 per cent. tincture of opium in sterile distilled water may be gently instilled once or twice in twenty-four hours.

A suppository consisting of —

Extract of Belladonna  
Morphia

$\frac{1}{2}$  gr  
 $\frac{1}{4}$

will definitely lessen the patient's discomfort while a simple hypodermic injection of omnopon ( $\frac{1}{2}$  gr.) should be almost equally efficacious.

**REGULATION OF DIET AND HABITS**—In all cases of acute cystitis the patient should be in bed while the symptoms are severe. In subsiding acute and in chronic cases the patient should get up. The following rules with regard to diet should be observed: avoid red meat, game, salted meat and salted fish, pickled viands, sauces, spices, pepper, mustard, alcohol, especially spirits and coffee.

It will be a great advantage to the patient to keep strictly to certain other rules relating to general conduct such as avoiding fatigue, cold, constipation.

excessive sexual excitement, taking moderate regular daily exercise in the fresh air and keeping regular hours with regard to rest. Excitable subjects must endeavour to avoid emotional disturbances, as these undoubtedly exaggerate the symptoms very quickly.

**MEDICINAL TREATMENT**—The following principles should be kept in mind —

Copious fluids should be taken by mouth, if the urine is acid, alkaline medicines and waters taken by mouth will act as sedatives to the bladder, if the urine is alkaline some comfort may be obtained by taking certain acids by the mouth. During acute periods of cystitis many urinary antiseptics increase bladder irritability and should be avoided, therefore in acute cases attempts to sterilize the urine should be reserved for the period of subsidence of the bladder symptoms. (For details of medicinal treatment, see p. 769.)

**TREATMENT OF PREDISPOSING LESIONS**—It is essential to seek out and eradicate any condition which is likely to have caused the cystitis. In many cases of mild chronic cystitis, especially in women, the prognosis can be greatly improved by treatment where necessary to the urethra. Intermittent urethral dilatations or light fulguration of well developed hillocks and inflammatory polypi if present are sometimes essential measures and often have a dramatic effect. Cauterization of the uterine cervix after the canal has been gently dilated where an erosion is present is an equally important and helpful measure. Chronic inflammatory conditions of the body of the uterus, especially where these have resulted in the latter taking up a retroposed position must be dealt with until remedied, otherwise the tendency to cystitis will persist.

In the absence of acute infection local treatment to the urethra, when a granulomatous condition is found to be present, is effective in favourably influencing the vesical symptoms. In the majority of cases the most satisfactory treatment is regular intermittent dilation. In certain refractory cases a short course, lasting one week, of daily instillations on to the vesical trigone of increasing strengths of silver nitrate, from  $\frac{1}{2}$  to 2 per cent, is effective in alleviating the symptoms.

The treatment by urethral dilatation should be carried out at gradually increasing intervals all the while progress is made by this routine. If the treatments are given roughly, excessively or too frequently the symptoms will be made worse rather than better. Between the first two treatments there should be an interval of three weeks, subsequently the intervals between the treatments should be gradually extended from one month to six weeks, two three four, six and twelve months according to progress, but in early cases one treatment or even the dilating effect of a cystoscopic examination may have the dramatic effect of ridding the patient of the symptoms. The following changes in the patient's symptoms are generally to be noted as a result of the treatment, in the order mentioned: aggravated for a short period, improved, a tendency to relapse. It is only when the last phase has set in, that the treatment should be repeated.

The treatment is equally effective in either sex. In the case of women an ultimate dilatation to 30 Charrière—or even larger using straight or curved metal dilators—should be the objective, whereas in men this extreme is generally too high. 26 Charrière being the point beyond which the dilatation should not usually be taken, although in the course of time some cases can safely be taken higher. Observations with the urethroscope show that most of the lesions mentioned disappear as a result of the treatment no doubt by promoting drainage from the foci mentioned, but in the more advanced cases of urethral polypi light fulguration will be necessary.

The improvement not only in local but also in regard to such general symptoms as a tendency to headaches nausea or vomiting or rheumatic manifestations is a gratifying feature of this form of treatment in many cases.

It must be remembered, however, that where old standing chronic changes in the bladder, vagina or of the ureter are already established, treatment to the urethra will be correspondingly less effective on the bladder symptoms.

Following fulguration treatment it is often necessary to give a few intermittent dilatations of the urethra commencing 2 or 3 months after the operation and continuing at intervals of several months.

**TREATMENT OF THE BLADDER BY LAVAGE OR INSTILLATION**—These forms of treatment must be regulated according to each individual case. Lavage is carried out with a large quantity of fluid which is generally an antiseptic in weak solution. Instillation means the introduction into the bladder of a small quantity of concentrated antiseptic which is allowed to remain there.

**Vesical lavage**—This should be carried out through a catheter. The method of Janet in which no catheter is used is not recommended for this type of case. The fluid, which should be lukewarm should be injected with a syringe rather than from an irrigation reservoir. A large capacity syringe should not be used (Fig. 179). In this way there is accurate control over the amount injected and the force applied in making the injection. These are both matters which call for judgment according to the irritability of the bladder. Small amounts, injected with gentleness, are essential requirements in the more sensitive cases. The quantity of liquid injected should not be such as to put the bladder into a state of tension. After one injection is made the next should follow before the fluid from the first has completely run out, in this way pain caused by the contraction of the bladder on to the catheter may be avoided. The irrigation should be continued until the fluid returns clear. As a general rule the irrigations should be made daily until such time as no further improvement results from them.

It should be remembered that antiseptic lotions used for the irrigation in too great strength will do more harm than good, and if in doubt as to what strength of a lotion to use, choose a weak rather than a strong concentration. There is a fairly wide choice of antiseptics which may be used, and the benefit from a particular lotion in a given strength will be found to vary in different cases, therefore the choice of the lotion and the strength in which it is used are matters which will call for special consideration as each case arises. The lotions given below in the strength stated are satisfactory.

Silver nitrate is particularly useful when bleeding is a feature, sodium bicarbonate when there is a large amount of mucus present and acetic acid in the presence of increased cystitis.

Silver Nitrate	1 in 10,000 to 1 in 20,000
Protargol	1 " 500 " 1 " 2,000
Argyrol	1 " 500 " 1 " 2,000
Oxycyanide of Mercury	1 " 4,000 " 1 " 8,000
Bimiodide of Mercury	1 " 10,000 " 1 " 20,000
Potassium Permanganate	1 " 5,000 " 1 " 10,000
Hydrogen Peroxide	1 " 4,000 " 1 " 8,000
Acetic Acid	$\frac{1}{2}$ per cent
Sodium Bicarbonate	1 to 2 per cent
Lysol	$\frac{1}{2}$ " 1 " "
Boric Acid	2 " 4 " "

**Vesical instillations**—Small quantities of antiseptics in more powerful

concentrations are sometimes very beneficial. The injections are made through a catheter by means of a syringe which has a nozzle specially made to fit the end of the catheter. One to two drachms are injected. The injections are made daily in increasing strengths. As the condition improves the instillations may in due course be replaced by lavage.

Very strong instillations have been used in the past, and it is questionable whether such a practice does not do more harm than good. In lesser strengths however this form of treatment is definitely helpful. The following substances in the strengths indicated are recommended —

Silver Nitrate	$\frac{1}{2}$ to 2 per cent
Argyrol	1 " 5 "
Protargol	1 " 5 " "
Collargol	1 " 5 " "
Gomenol	4 " 10 " "

**INDWELLING CATHETER DRAINAGE.**—This is often a suitable method of giving continuous bladder drainage for a short period and at the same time allowing for frequent vesical irrigation. Unfortunately in the male septic complications from the presence of the catheter have a very definite relation ship to the time the catheter remains in the urethra. Epididymitis, prostatitis and periurethral abscess are all encountered, while urethral stricture may occur as a late complication where the catheter has remained in the urethra for periods of ten days or more. It is a matter of experience that any of these complications is infrequent as a result of the presence of the catheter up to forty eight hours. It is wise therefore in the male to limit this form of drainage to within this period of time if possible.

The best form of catheter for this purpose is a rubber one and the most satisfactory type is the Marion catheter which has three eyes or more, is easy to pass and can be tied in with tapes (Fig. 111 c). When an ordinary rubber catheter—which is softer than a Marion—is used, this is most conveniently fixed with four strips of adhesive plaster each of which is wound for a turn or two round the catheter and then fixed longitudinally to the whole length of the skin of the penis and uniformly arranged round it. The strips are reinforced with a circular piece wound twice round the penis. Sizes 18 or 20 French are quite large enough for this purpose. Gum elastic catheters although commonly used cause more trauma to the urethra and are conveniently fixed to the penis by four strands of tape held in position by adhesive plaster which encircles the penis. The best type of gum elastic catheter for this purpose is the Bazy which has five eyes. If catheter drainage is to be continued for prolonged periods the catheter should be changed after three days.

In females a self retaining form of catheter which is introduced on a stylet is necessary. Malecot and de Pezzer are popular types (Figs. 175 and 176).

**SUPRAPUBIC CYSTOSTOMY.**—The justification for this procedure exists in certain subacute or chronic cases where there is retention from the presence of blood clot or masses of debris and where chronic cystitis is a complication of retention of urine from other causes. In the last category the commonest cause is prostatic obstruction. Where there is an absence of clot or debris the bladder may be opened in a simple manner by using a trocar (Fig. 174) (Fig. 187). This may be necessary not only in certain cases of bladder neck obstruction but also where the cause of the cystitis is retention of urine from disease or injury of the nerve supply of the bladder.

**CONTINUOUS IRRIGATION** is a valuable method in very septic cases or when



hemorrhage is a prominent feature. It is most satisfactorily employed after suprapubic cystostomy has been established. It may then be carried out in conjunction with an indwelling urethral catheter or entirely through the suprapubic fistula. In the former case the direction of the flow is most conveniently arranged so that the fluid enters by the catheter and leaves through a self retaining suprapubic tube (Fig 359) or a short suprapubic tube which should open into an Irving's box (Fig 188). When an indwelling

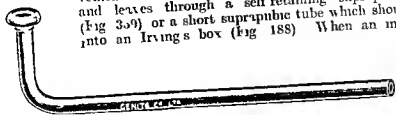


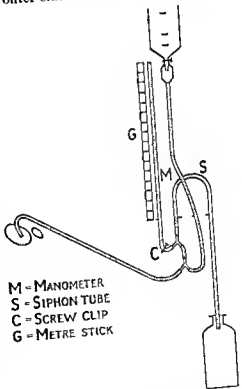
FIG 359

W. J. W. to self retaining suprapubic tube for bladder drainage

catheter is not employed a Marion's suprapubic tube will meet requirements. This has a small inlet tube fixed to the outer side of the wide bore channel. Continuous irrigation through a two way indwelling catheter is an alternative method which requires constant supervision in case of blockage.

Normal saline should be used as the irrigating medium if this method is to be employed for any length of time. Antiseptic fluids unless in very weak solutions should be used for short periods only and are better not used at all unless there is a suprapubic opening. Even if the latter provision exists a constant watch must be kept on the pulse for evidence of absorption.

**TIDAL DRAINAGE**—This is a system which provides the bladder with both drainage and irrigation through either a suprapubic tube or an indwelling catheter. The principle of the process is based on siphonage. The method is an old one and has been advocated by Munro (1936). More recently the apparatus has been simplified by Wells (1942) and Piches (1943) (Fig 360). Where drainage is required for long periods the suprapubic method should be used because of the evil consequences from the extended use of the indwelling urethral catheter.



M = MANOMETER  
S = SIPHON TUBE  
C = SCREW CLIP  
G = METRE STICK

FIG 360

Recess Double-tube tidal drainage and cystometer used with a suprapubic or urethral catheter. The clip (C) is closed sufficiently to prevent the siphon from breaking before the bladder is empty.

**TREATMENT ACCORDING TO TYPE OF CYSTITIS**—*Acute and severe chronic cystitis*—Because of the reduced capacity of the bladder as a result of its con-

tracted state any form of lavage is contraindicated for the reason that such intervention will increase the intravesical tension and greatly aggravate the pain. Instillations of small quantities of various medicaments are objectionable for the same reason.

Treatment should proceed along the lines of supervision of diet and the bowels, medicinal measures and the administration of fluids as laid down elsewhere. When the acute symptoms have subsided it is essential to make a thorough search for a chronic focus of infection which may have initiated the acute attack as stressed in more detail under Treatment of predisposing lesion.

*Subacute and chronic cystitis*.—In these cases regular daily lavage for a limited period is generally of benefit. Weak rather than strong concentrations of lotion should be chosen. It is sometimes an advantage to change from one lotion to another after a period. At the end of the irrigation an instillation is sometimes an extra advantage. Gomenol which is an oily solution often has a comforting effect when employed in this way.

A short period of indwelling catheter drainage is sometimes of special advantage in the presence of residual urine. In other cases particularly where an obstructive condition has to be dealt with suprapubic cystostomy may be necessary.

In seeking for a cure in these cases the prime necessity must always be kept in mind of seeking out and dealing with the predisposing cause whether it be an obstructive condition or a distant or neighbouring focus of infection.

*Hæmorrhagic cystitis*.—The acute form does call for treatment which differs from that of other acute forms of cystitis but in the chronic form because the bleeding may be due to changes in the mucous membrane for which the more common methods of treatment are not always efficacious more active intervention is often required. Actual vegetations should be treated by light fulguration and incrustations which have resisted lavage and medication indefinitely will require to be removed by swabbing or curettage through the suprapubic approach. Lavage with oxycyanide of mercury or silver nitrate (see p 697) is generally very satisfactory treatment for hæmaturia resulting from congestion due to *B. coli*.

*Cystic cystitis and glandular cystitis*.—Treatment by instillations sometimes gives relief. It is more efficacious as a rule to lightly touch each cyst or other inflammatory prominence with a fulgurating electrode using only a weak current. This treatment is particularly efficacious when applied to cysts or inflammatory hillocks about the neck of the bladder.

*Membranous cystitis*.—It is only in women that the exfoliated mass which is thrown off from the mucous surface has an opportunity of passing spontaneously per urethram. In men therefore and sometimes in women it will be necessary to open the bladder above the pubis in order to remove the gross products of inflammation.

*Incrusted cystitis*.—Daily irrigation of the bladder with a weak solution of acetic acid (see p 697) may suffice in mild cases. G solution (Suby *et al* 1943) is also advocated. Where the deposits are few and small they may be effectively treated by fulguration. In other cases it is essential to forcibly detach the calcareous masses. The bladder should be opened above the pubis and after a good exposure with a suitable bladder retractor each incrustation should be removed by applying a sharp spoon firmly to it. It may be necessary to maintain prolonged suprapubic drainage in order to obviate the tendency for the incrustations to recur.

*Cystitis with leucoplakia*—When the patches are small and few they should be treated by fulguration through a cystoscope taking care to use a light current and to burn only superficially. When the condition is extensive it is wiser to open the bladder and to excise the plaques where possible.

*Intractable cystitis*—In many of these cases it will be wise to have recourse to cystostomy. Sometimes the opening of the bladder will render accessible a lesion which can be excised, curetted or fulgurated while the subsequent bladder drainage is almost invariably a beneficial procedure. Often prolonged bladder drainage causes considerable improvement and restores the patient to a tolerable degree of comfort after the fistula has been allowed to close. In other cases it is wise to leave the patient with a permanent cystostomy. Marion (1935) speaks highly of radium as a means of relief in certain cases of intractable cystitis and of hemorrhagic cystitis. He advises the intravesical application of a small dose for a short period—50 mg. for twelve hours.

### ULCERS OF THE BLADDER

A great variety of ulcers in the bladder is recognized by cystoscopy. They may be classified as follows: traumatic ulcers, ulcers accompanying cystitis, tuberculous ulcers, syphilitic ulcers, ulcers of new growths, simple ulcers.

Only traumatic and simple ulcers will be studied here; the others are described in connection with the diseases which cause them.

*Traumatic ulcers*—In a minor degree pressure from an indwelling catheter may be responsible for superficial ulceration. It results from contact of the bladder wall with the tip and from pressure of the catheter on the trigone. The complication is most easily avoided by using rubber catheters and realizing that short periods of this form of drainage often give the maximum benefit. Gripping the mucous membrane with a lithotrite may be a cause of ulceration especially when the bladder does not contain enough fluid.

The unskilful handling of the cystoscope and of other instruments passed per urethram may produce lesions which call attention to the necessity for exercising great care when these are used. Such lesions occur most often at the bladder neck and on the posterior wall.

Calculus and foreign body commonly cause vesical ulceration.

*Simple ulcers*—*ETIOLOGY*—They may occur as a result of trophic changes resulting from injury or disease of the spinal cord.

Thrombosis in a vesical blood vessel due to some distant infective condition may produce a localized patch of ulceration. Single ulcers with punched out edges occur spontaneously and independently of generalized cystitis at the bases of small vesical sacculi.

*PATHOLOGICAL ANATOMY*—The common sites of ulceration are on the trigone and on the posterior wall above the line of the peritoneal reflection.

*Macroscopically* the solitary ulcer may be quite superficial or involve all the vesical coats. It often has a punched out appearance with raised edges. The diameter of the ulcer may be no more than  $\frac{1}{4}$  in. or may be much greater.

*Microscopically* the central or necrotic zone is surrounded by tissue undergoing necrosis and epithelial cells are absent and only a few scattered leucocytes are seen. Outside of this zone the epithelium tends to become healthy in appearance but the underlying tissue shows disorganization from a blood stained exudate containing many red cells. The blood vessels are dilated and packed with corpuscles. If the ulcer extends deep enough the fibres of the muscular coat are seen to be dispersed by the exudation. Thrombosis in arteries is commonly seen.

**SYMPTOMS SIGNS AND COURSE**—Hæmaturia is sometimes the outstanding feature and is often abundant. Generally it is accompanied by other symptoms indicating cystitis namely dysuria pain and frequency of micturition. In certain cases dysuria and pain may be very persistent. An ulcer may cure itself spontaneously without treatment or it may require active measures. If it has a prolonged course it may become incrustated with calculous debris. It may go on to perforation. There are certain ulcers which have a marked tendency to necrosis from the beginning these are the ones that go on to perforation which generally occurs fairly soon after the onset of the ulceration so that the clinical features of this complication may be looked for within about a week of the onset of the symptoms of cystitis. Evidence of peritonitis may be the indication of what has occurred. This will probably be accompanied by a falling off in the amount of urine passed per urethram—only early surgical intervention can save the patient's life.

**DIAGNOSIS**—Cystoscopy is the only satisfactory way of making the diagnosis. When perforation has occurred signs of cystitis and peritonitis will be present together. The presence of little or no urine in the bladder on catheterization should confirm the diagnosis.

**TREATMENT**—When a simple ulcer is found to be present on cystoscopy treatment of the cystitis by lavage with silver nitrate (see p. 697) will often clear up the ulceration. An ulcer which will not respond to this attack should certainly be treated by fulguration. The ulcerated surface should be lightly brushed over by the electrode carrying a weak coagulating current. This method gives such good results that one application generally suffices. Zinc ionization has been enthusiastically recommended by Wells (1941) for this condition.

When perforation into the peritoneal cavity has occurred it is necessary to open the abdomen, close the perforation from the bladder, mop up the extravasated urine and drain the pouch of Douglas and the bladder suprapubically.

### GANGRENE OF THE BLADDER

**Ætiology and pathology**—There are three conditions that lead to gangrene of the bladder—

- 1 Pregnancy
- 2 The injection of intensely irritating fluids into the bladder
- 3 Following retention of urine due to disease or injury of the nerve supply of the bladder particularly where the retention is due to a spinal cord lesion

Two factors in particular seem to lead to the condition these are mechanical and inflammatory.

Vesical gangrene is characterized by necrosis of the whole of the inner wall of the bladder which tends to become detached in one piece.

An examination of the slough shows that it comprises the mucous submucous and part of the muscular coats and that the whole mass is in a state of degeneration. There is a complete disappearance of the epithelium.

**Symptoms and signs**—Following the injections of strong fluids into the bladder the onset is characterized by the features of cystitis with distressing symptoms. But when the gangrene supervenes insidiously retention of urine, catheterization and the appearance of signs of infection in the urine mark the successive steps as the condition progresses.

Difficult micturition—sometimes with complete retention—dysuria and

where the condition is not consequent upon a spinal cord lesion stabbing pains in the bladder

The urine is characteristic it has a foetid odour is greenish in appearance and has a thick deposit which contains particles of slough These features in the urine are sometimes present in cases of sloughing carcinoma of the bladder

On catheterization in spite of the palpably distended bladder the urine does not come freely and an attempt to improve the flow by injecting fluid through the catheter generally fails to improve matters Withdrawal of the catheter will show the reason for this in the presence of debris blocking the lumen

The general condition of the patient must necessarily be serious With a knowledge of all the circumstances of the case there should be no difficulty in making a diagnosis

**Prognosis**—The first impression may fail to indicate the real gravity of the case Prompt intervention with the proper treatment may save the patient Recovery with cicatrization of the bladder results in a diminution of capacity and thus increased frequency of micturition and even incontinence of urine When the ureteric orifices are constricted by scar tissue infective complications of the kidneys may be expected

**Treatment**—Attempts to drain the bladder by indwelling catheter generally waste valuable time and are only justifiable when the diagnosis is in doubt When this is certain suprapubic cystostomy should be established without delay at the same time removing any slough which is present

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## CHAPTER LXVI

### PERICYSTITIS

**T**HIS is inflammation of the cellular tissue surrounding the bladder

#### ÆTIOLOGY

The inflammation may result from infection which has spread from the bladder and it may originate in the organs or tissues adjacent to the bladder

**Pericystitis of vesical origin**—This may be traumatic inflammatory or neoplastic

**TRAUMATISM OF THE BLADDER** may result from projectiles sharp ended instruments other foreign bodies rupture of the bladder from various causes intravesical operations such as lithotomy fulguration the mere opening of the bladder especially when the bladder incision is subsequently completely closed or during the excision of new growths or diverticula prostatectomy and other operations on the bladder neck such as the different forms of per urethral resection

**CYSTITIS**—Any form of vesical inflammation can result in pericystitis especially when of long duration Pericystitis is most frequently associated with prostatic enlargement vesical calculus diverticulum or urethral stricture Vesical tuberculosis gives rise to a perivesical reaction which may be a simple or a specific infection

**VESICAL NEOPLASMS** can precipitate an ordinary perivesical infection in their vicinity but more often the infiltration is neoplastic

**Pericystitis of extravesimal origin**—This may arise from a variety of causes from any of the structures in the immediate vicinity which have formed adhesions with the bladder as a result of simple inflammation tuberculosis or neoplasm inflammation in the cellular tissue of the pelvis may equally be the cause of the infection of the perivesical cellular tissue as for example from the broad ligament or space of Retzius

#### PATHOLOGY

In the majority of cases the infecting organism is the colon bacillus streptococcus staphylococcus or one of the anaerobes

There is a variety of methods by which the spread of the organisms can occur —

- 1 By direct spread through the tissues either from the interior of the bladder or from a neighbouring organ
- 2 By way of the lymphatics either from the bladder or an adjacent structure
- 3 By direct inoculation the organisms reaching the cellular tissue as a result of a solution of continuity either of the bladder wall or an adjacent organ
- 4 By way of the blood stream this is probably a rare method of spread

## PATHOLOGICAL ANATOMY

Different degrees of perivesical inflammation are encountered as follows  
 oedematous fibro fatty with diffuse suppuration with abscess formation

**Oedematous pericystitis**—This condition is often recognized on approaching the bladder through a suprapubic incision and in more advanced cases can be identified on rectal or vaginal examination and becomes more obvious as the condition advances towards a further stage of inflammation

**Fibro-fatty pericystitis**—This is common with chronic cystitis especially where there is chronic prostatic disease The loss of resiliency of the bladder wall is in part due to this condition

The lesion is characterized by a transformation of the scanty and loose cellular tissue bed of the bladder into a thick and somewhat fixed mass of fat and fibrous tissue The proportion of fat to fibrous tissue varies in different cases These changes may be diffuse or localized to certain parts of the bladder In the former case the bladder is enclosed in a firm shell of fibro fatty tissue When situated at the base of the bladder the mass may include the seminal vesicles the vas deferens and the ureters By constricting the last structures obstruction and dilatation may be caused

**Pericystitis with abscess formation**—This may take the form of small multiple and widespread abscesses in the perivesical tissue which is the seat of less severe acute or chronic changes as well or there may be one large abscess or several considerable collections of pus The ultimate formation of a large cold abscess is sometimes a sequel This may be so pronounced as to give the appearance to the abdominal wall of a distended bladder or the pus may extend into adjacent connective tissue zones and in this way be found in the space of Retzius the inguinal region the iliac fossa or even mount as high as the kidney which it may completely envelop The pus may in due course escape by causing perforation of the bladder vagina or rectum

**Pericystitis with diffuse suppuration**—In this type there is a rapid spread of a severe infection and the features of the case resemble those of extra vesication of urine in the tendency to the formation of sloughs

## SYMPTOMS SIGNS AND DIAGNOSIS

**Latent pericystitis**—It is simple for pericystitis to pass undetected where symptoms of cystitis have been pronounced In certain cases of suppurating pericystitis there may be only general phenomena with little or nothing to attract attention locally and only a methodical investigation will reveal the true state of affairs

**Oedematous pericystitis**—When this occurs in the course of an acute cystitis it can easily escape detection by rectal or vaginal examination if no thickening is palpable In certain cases where the bladder has lost its capacity to distend this change may be considered to be due to the obvious chronic cystitis rather than to the existence of a fibro lipomatous change round the bladder

**Pericystitis of extravasical origin**—These cases are more easy to recognize because of the appearance of symptoms in relation to the bladder in the course of disease of an organ which is adjacent to the bladder Frequency of micturition and dysuria in the course of appendicitis or salpingitis or a new growth of the uterus or rectum should raise the question of pericystitis Investigation should in due course reveal the original seat of disease Sometimes cystoscopy will indicate what is going on by showing an area of oedema of the bladder wall which is localized and which is thus in sharp contrast to the rest of the vesical mucosa

into the bladder or externally. An untreated abscess which does not open is quite likely to cause the death of the patient.

A perivesical abscess which opens spontaneously may result in cure or it may persist indefinitely in a modified form. Complete cure may not be achieved because of the persistence of the fibrous walls of the abscess cavity which if it opens into the bladder may become filled with urine.

The abscess may open into the bowel, the vagina or externally, and if such an opening is accompanied by one into the bladder as well, a urinary fistula may be the ultimate condition.

**Acute diffuse suppurative pericystitis**—Such cases can offer only a grave prognosis. The condition soon becomes complicated by septicæmia and leads inevitably to death. Only intervention in the earliest stage offers any prospect of curing the patient. The special difficulty is in diagnosing the condition before it is well established.

### TREATMENT

In the earliest stage, i.e. with *oedematous pericystitis*, the treatment is directed towards the cystitis which has caused the inflammation outside the bladder. At this stage local applications such as antiphlogistine and internal antiseptics such as sulphathiazole, sulphadiazine or sulphamezathine are called for. On the other hand with the *fibro lipomatous* type treatment is likewise directed towards the bladder condition.

**Chronic abscess**—All cases will require incision and drainage as soon as it is established that a collection of pus is present. It is usually advisable to establish suprapubic cystostomy as well and the two requirements are fulfilled at one and the same time.

In *post-operative pericystitis*, as for example after prostatectomy, a sharp lookout must be kept for any sign of a localized swelling which must be opened and drained as soon as identified.

**Suppuration of extravescical origin**—Surgical intervention is called for upon the organ from which the suppuration originates as soon as the presence of pus is established.

If the abscess has already opened into the bladder, the sinus so established may not be sufficiently adequate to bring about a spontaneous cure. In these circumstances drainage should be provided both for the extravescical focus and for the bladder itself.

**Acute suppurative pericystitis of vesical origin**—This has a marked tendency to discharge itself into the bladder. With this knowledge if the general condition of the patient warrants it, any inclination to intervene surgically should be restrained. Should there be undue delay in the rupture of the abscess accompanied by a deterioration in the patient's general condition, the abscess should be opened and drained through an extraperitoneal incision either suprapubically or in the inguinal region.

**Diffuse suppurative pericystitis**—This requires early and efficient drainage. Unfortunately the difficulty of being certain in the initial stage that incision is going to be necessary generally results in surgical intervention being too late. Multiple and large incisions will certainly be called for when the pus is widely distributed.

For the treatment of fistula resulting from perivesical abscess see Vesical Fistula.

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## CHAPTER LXVII

### INFECTIONS OF THE KIDNEYS AND URETERS

**I**NFECTIONS of the kidneys occur very commonly. They are met with at all ages and in both sexes; they are of greater frequency in the female than in the male. Unilateral infection is commoner than bilateral.

#### ÆTIOLOGY

**Bacteria**—Ureteric catheter specimens taken from chronic cases of renal infection show a high proportion of coliform bacilli. Clinically the colon bacillus is found in the great majority of cases of kidney infections in females, and of pregnancy cases in particular, and also in most cases of ascending infection.

There has been some confusion concerning the frequency with which the different varieties of organisms have been responsible for renal infections. This largely arises from the fact that the specimen of urine is collected from the bladder and not the kidney. For in bladder urine it is well known how repeated examinations of the same case can give a variety of findings.

The colon bacillus, although frequently present, is commonly associated with other organisms. The prognosis in the presence of streptococcus faecalis and bacillus proteus is particularly bad. It must be kept in mind that the attack on the kidneys may be both blood borne and ascending. The bacillus coli, although more commonly present, is less virulent. Coccal infections give a much higher mortality.

Of the coliform varieties, that known as *escherichia coli* is by far the commonest, but the aerobacter aerogenes occurs not infrequently. Staphylococcus aureus and albus are next in importance, and frequently appear as secondary organisms. In contrast with the coliform infection, which is commoner in ascending infection, coccal invasion of the kidney is commoner by the hæmatogenous route, particularly where the source is some peripheral lesion such as carbuncle or osteomyelitis. Staphylococcus aureus is of special importance because of its urea splitting properties and is apt to lead to the formation of stone.

Bacillus proteus—of which the commonest variety is the proteus ammoniac—and streptococcus faecalis are not uncommonly found, and are important because they also have the power of decomposing urea. These organisms commonly appear in the urine of patients who have had operations on the kidney or bladder, followed by drainage of these organs.

In typhoid fever it is well known that a certain proportion of the patients pass typhoid bacilli in the urine.

The gonococcus must be regarded as a rare cause of renal infection.

**The origin of the infection**—Pyelonephritis may occur as a complication in the course of a general infection such as influenza, pyæmia, typhoid, etc., more frequently the origin is the lower urinary tract or the genitals, less frequently the intestinal tract. Lesions of the skin such as boils and furuncles, tonsillitis and dental abscess may also occasion renal infections.

**Routes to the kidney**—There are three separate paths giving access to the kidney from a distant focus of infection. The blood stream, or descending

route the lumen of the ureter the lymphatics outside of the ureter The last two are different pathways of the ascending route It should be borne in mind that the ascending routes provide the great majority of cases

There is reason to believe that from the urethra and the periurethral tissues renal infection can take place by both ascending and descending routes at the same time The experimental work of Thiele and Embleton (1913) has shown that this occurs Cabot (1936) believes that clinical indications are that the two methods of spread probably occur in the same case This phenomenon is seen as a result of urethral instrumentation Post mortem findings in these cases show two types of pathology suggesting that both routes have been used one in which the kidneys only are the seat of sepsis the other in which the purulent processes occur not only in the kidney but also widely distributed about the body

The most acceptable interpretation of the two pathological pictures both resulting from urethral instrumentation is that they represent different degrees in the extent of the invasion which can be set in motion The lesser degree represents infection of the kidney by ascent the greater degree not only the direct invasion of the kidneys but a severe flooding by organisms of the blood stream

**THE HEMATOGENOUS ROUTE**—It is interesting to discriminate between two distinct clinical types —

- 1 Those that arise in association with a peripheral lesion unassociated with the genital and urinary systems
- 2 Those that follow urethral instrumentation

In the former group are those which occur with such distant lesions as dental abscess tonsillor or other upper respiratory tract infections boils and carbuncles of the skin These are coecal lesions usually due to the staphylococcus aureus and are definitely blood borne

The second group is often puzzling from more than one point of view The fatal cases commonly show widespread suppurating foci in different parts of the body for example in addition to being found in the kidney abscesses have been discovered in the lungs spleen cerebrum together with suppurative endocarditis and meningitis

In some of these cases infection is known to be present in the lower urinary tract before the instrumentation is carried out and when renal tenderness and other signs of kidney inflammation occur following the passage of the instrument it is perfectly logical to conclude that the infection has occurred by the ascending route (see ascending infection) but when septic foci develop in other parts of the body as a result of the same intervention it is obvious that a blood stream invasion has occurred in which of course the kidney may have shared Thus we may have a state of affairs in which the kidney has been attacked by both the ascending and the descending routes

The whole process is more easily understood if we regard the instrumentation as stirring up an existing infection rather than introducing a fresh one The most severe reactions are seen in old stricture cases in these the urethral tissues in the vicinity of and behind the stricture are in a state of chronic inflammation The rapid and overwhelming manner in which the invasion can occur is difficult to explain on the basis of the introduction of a few fresh organisms into the tissues It is not difficult on the other hand to understand how a veritable nest of organisms can be stirred into activity by traumatizing a chronically inflamed area so that they would be able to reach the kidney by every available route

are often to be discovered. In the male the prostate or seminal vesicles are by far the commonest sites for the infection.

Often the mistake is made of assuming that these organs are blameless because palpation alone does not reveal a change. *Urethroscopy* is often necessary before it can be definitely established that the focus is in the urethra. This applies particularly to the female in whom the urethra is regularly overlooked as a possible cause of the patient's symptoms (see urethro trigonitis). Hanley found that in 246 cases of pyelitis in women 58.5 per cent had urethroscopic evidence of urethro trigonitis.

Cystoscopy is particularly interesting in the early chronic cases. Let us consider for example a case complaining of mild chronic frequency of micturition with aching in one loin. Some mild generalized dilatation of the renal pelvis is present—as indicated by an intravenous urogram—which is not due to any obstructive cause. The urine in such a case generally contains no pus cells and there may or may not be a few cocciform bacilli or other organisms present.

A search of the pelvic contents reveals a cervical erosion. Cystoscopy is as likely as not to show no abnormality in the bladder except on the front of the trigone where in early chronic inflammatory change is detected. As likely as not urethroscopy will show a chronic inflammatory change in the posterior urethra. Thus an inflammatory state is present aptly described as urethro trigonitis.

In the past the complete absence of an inflammatory change from the general bladder cavity and the ureteric orifices has tended to discount the possibility that the renal symptoms were due to an ascending infection.

*The pathway outside the ureter (lymph channels).*—A good deal of experimental work has been done by various investigators in the hope of demonstrating direct lymphatic pathways up the ureters. The theory has naturally seemed a hopeful one as on first sight the wall of the ureter presents itself as a structure which is very likely to provide the scaffolding for a direct system of channels between the lower urinary tract and the kidneys. But the strongly developed external lateral lymphatic drainage of the ureter which is easy to demonstrate experimentally is a firm barrier against this method of ascent. My own experiments on animals with indian ink have corroborated this most clearly.

We may well ask why in the presence of one of these pelvic foci of infection are symptoms implicating the kidneys so commonly present while other organs appear to escape? In answer to this question it is difficult to avoid the conclusion that from the pelvic floor there are pathways that lead more readily to the kidneys than to other organs. The question then arises what are these pathways?

As Thompson has pointed out in Chapter I the cellular tissue surrounding the bladder, prostate, testicles, spermatic cord, vagina, uterus, Fallopian tubes, ovaries and rectum is in direct continuity with the cellular tissue which occupies the renal hilum and which surrounds the kidney. Thus upward connection is established by a sheath which has been carried by each kidney as it ascended from the hollow of the sacrum. The dome of this envelope closely envelops the upper pole of the kidney, the base is wide open to the pelvic cellular tissue. Thus it is that the spread of an inflammatory process from any pelvic organ is shepherded by this fascial sheath towards the kidney.

The whole fascial process is known as the urogenital fascia (Fig. 1). It provides the explanation of the common occurrence of upper urinary tract symptoms as a result of genital and lower urinary tract infections. The

frequent presence of phleboliths in the true pelvis and of calcified glands along the upward lymphatic route from the pelvic floor found in association with symptoms relating to the kidneys is a constant reminder of the need to make a detailed investigation of the genital system when an X ray shows any of these to be present

Helmholz (1918 and 1922) produced some valuable data regarding ascending infection as a result of experiments on rabbits. Cultures of *B. coli communis*

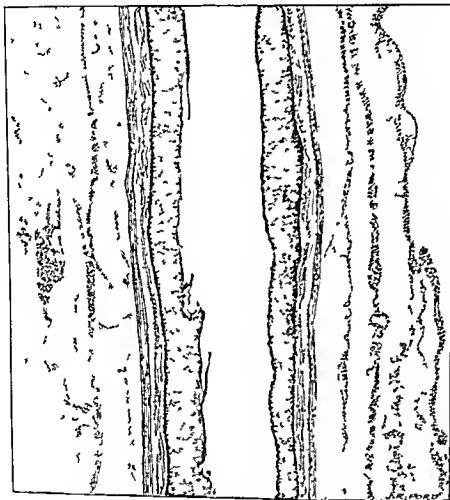


FIG 361

Longitudinal section of ureter in lumbar region. The strands which run more or less parallel to the ureter show streams of phagocytes laden with ink

were placed in the interior of the bladder and the results noted. These experiments clearly showed that the infection spread from the bladder to the kidneys by way of the perireteral tissue into the peripelvic tissue. Walker (1922) in experiments on guinea pigs showed that ascent of infection takes place in the perireteral tissue. Experiments carried out by myself (1934 and 1936) in which indian ink was injected into the tissue of the bladder base in guinea pigs showed exactly the same process (Fig 361).

The renal capsule undoubtedly becomes infected in the early stages of ascending infection and Walker (1922) in his experiments showed that invasion of the kidney can occur through this structure.

It is generally assumed that ascending infection always reaches the renal parenchyma from the renal pelvis by way of the renal papillae. Doubtlessly this is the pathway of assault upon the kidney substance in certain circumstances especially when there is retention of urine in the bladder but there is evidence of a pathway into the kidney outside of the renal pelvis. The peripelvic tissue which carries the infection from below enters the hilum of the kidney to surround not only the pelvis but the major and the minor calyces as well. In the latter situations it not only makes intimate contact with the renal substance but it is traversed by the blood vessels which enter and leave the kidney.

My own experiments with rabbits rats and guinea pigs showed quite clearly the inflammatory infiltrations entering the renal substance following the course but outside of the blood vessels.

Helmholz noted in his experiments collections of leucocytes in the peripelvic tissue from which the renal substance at times was directly invaded. Regarding these experiments Cabot has called attention to the extensive thrombosis of the veins surrounding the pelvis. He thinks that these show evidence of an upward spread from the pelvis through the kidney following the course of the blood vessels.

Legueu (1921) remarked upon the fact that in ascending infection the infiltration of inflammatory tissue round the pelvis is continued into the renal substance round the blood vessels. Again he says that from animal experiments it is clear that these lesions spread rapidly.

Both these points were demonstrated in my own animal experiments bearing on ascending infection namely that infection spreads from the hilum into the renal substance in the perivascular tissue in which it can be seen to be distributed throughout the renal substance and that infection of the kidney may occur within a few hours of an infection being acquired in the prostate cervix or urethra. The fibro fatty infiltration of the renal substance from the renal hilum which is commonly seen is certainly explicable according to this theory.

**Predisposing causes of renal infection**—The mere passage of organisms via the blood stream through the kidney does not suffice to produce infection, but if in virtue of the prolonged nature or of the virulence of the attack this does occur then the renal infection may be said to be due to some predisposing factor such as renal retention nephritis stone new growth traumatism congestion of pregnancy excessive functional activity of the kidney injurious substances taken by mouth etc. Broadly speaking as regards aetiology pyelonephritis may be divided into two groups—

- 1 Pyelonephritis in a kidney previously healthy but in a state of congestion from some temporary cause as occurs in pregnancy influenza a severe chill etc
- 2 Pyelonephritis in a kidney which is already diseased as for example in hydronephrosis stone new growth etc

Pathology anywhere in the urinary tract can lead to renal infection. Hanley (1946) found that in 246 cases of pyelitis in women there was either a history of previous urinary tract infection or evidence of co existing pathology in the urinary tract in 81 per cent.

The infecting agent in either group comes from the urinary genital or intestinal tract or from some other part of the body. In the former group an attack in these circumstances will be designated according to its predisposing cause such as pyelitis of pregnancy.

## PATHOLOGICAL ANATOMY

Renal lesions from infection are necessarily complex. They vary according to the nature and presence of pre existing disease in the kidney to the type of invading organism and to whether the infection is acute or chronic.

In most cases the inflammation involves both the parenchyma and the pelvis together hence the term *pyelonephritis*. In some of the specimens it is possible to discriminate between inflammation of the pelvis and the parenchyma. In others the process definitely predominates in one or other of these localities appearing to have spread from one to the other.

It is a general principle that infection of the kidney tends sooner or later to involve the ureter as well. In many cases of renal inflammation it is not possible clinically to identify the different pathological categories for this reason no attempt is made to base the following descriptions on clinical types.

Because the specimens available for study nearly always show the latest stages of the disease it is impossible to know from them the sequence of events which preceded the terminal state. So much is this the case that the majority of pathologists do not claim to be able to distinguish microscopically between ascending and descending infection of the kidney.

**Acute pyelitis**—The pelvis is generally slightly dilated. The dilatation is probably due to an inhibiting action of the inflammatory process on the pelvic muscle. The walls tend to become thickened and lose their suppleness. The mucosa is reddened with some darkened areas due to submucous hæmorrhages. The epithelium is often desquamated. Throughout the pelvic structure there is seen a capillary dilatation and infiltration of leucocytes often petechial hæmorrhages are seen.

**Chronic pyelitis**—The pelvis is generally dilated and thickened and there is a certain amount of peripelvic fibro fatty infiltration present.

The mucosa presents appearances which vary according to the chronicity and course of the condition. It may be red granular or covered with a false membrane which is actually a slough upon which granules of phosphatic deposit may be seen. Sometimes patches of leucoplakia are apparent. At other times the surface of the mucosa is dotted with small cysts which resemble those seen in the bladder in certain cases of chronic cystitis.

Microscopically changes are to be noted in all the coats of the pelvis. Desquamation of epithelium in places and proliferation in others infiltration and sclerosis of the submucosa and of the muscular coat. Fibro fatty adhesions not only outside of the pelvis but also round the calyces and the blood vessels entering and leaving the renal substance. The perivascular sclerosis can often be traced right into the parenchyma.

In both acute and chronic pyelitis there are invariably associated lesions of the kidney itself.

**Subacute congestion of the kidney**—Death may occur from this in the course of a few days when the infection is overwhelming in character.

The kidneys are enlarged plum coloured with scattered hæmorrhages and of a consistence less firm than normal. The congested pelvis contains blood stained urine.

Microscopically an extreme dilatation of all the vessels is noted there are hæmorrhages both interstitial and into the tubules. The parenchyma is seen to be packed with the organisms which provoked the infection and leucocytes.

The rapid course of events hardly gives time for suppuration. Such changes are due to a blood borne invasion.

**Cortical suppuration**—In the first phase the aspect of the kidney is identical with the condition just described but the course being less overwhelming other lesions have an opportunity to develop. There is degeneration and desquamation of the epithelium masses of which from the glomeruli and tubules re formed into casts are found crowding these channels. Infiltration of leucocytes is noted in periglomerular peritubular and perivascular situations

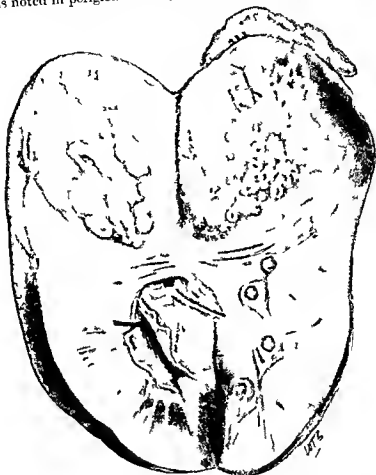


FIG 367

(Carbucle of kidney occupying the upper pole (D. D. J. MacLynn's case))

Suppuration in due course supervenes the kidney is increased in size from congestion on the surface appear innumerable small abscesses varying in size from a millet seed to that of a pea and also reddened projecting areas which have not yet reached the stage of suppuration. Section shows similar small abscesses deep in the renal substance (Fig 362)

Microscopically the abscesses are seen to be periglomerular and perivascular made up at their centre of leucocytes many of which are degenerated their walls are formed by the renal tissue which is infiltrated with polymorph leucocytes. The glomeruli tubules and intervening tissue show the same changes as described in the first phase

Sometimes a number of small abscesses will fuse to form a carbuncle. At times a triangular area of necrosis with its base towards the outer border and its apex towards a calyx will be defined. Such an appearance is most satisfactorily explained on the basis of a thrombosis in a renal vessel supplying the area.

The perirenal fat at this stage may show no great change in some cases while in others there is oedema and fibrosis of the fatty tissue. The opening of a renal abscess into the perirenal area is the commonest cause of perinephric suppuration and of perinephric inflammatory changes generally.

**Radiating suppuration**—The kidney is large from congestion and its surface is studded with numerous small abscesses.

On section the lesions are most pronounced in the pyramids. Here fine yellowish lines bordered by red zones are seen radiating like the straight tubules from the apex to the base of the pyramid. The cortical region will generally show a few abscesses but the suppuration clearly predominates in the medullary region.

Histologically it is seen that in the pyramidal regions where suppuration has not occurred there is dilatation of the straight tubules with epithelial changes and peritubular infiltration with leucocytes.

The yellowish lines are seen to be lines of suppuration consisting of leucocytic concentrations between which the straight tubules appear more or less in a state of necrosis. There are foci surrounded by zones of leucocytic infiltration with vascular dilatation and interstitial hæmorrhages. The cortical zone is less affected showing only tubular dilatation more often suppurating foci are found. In some cases the suppurating cortical lesions correspond with the lesions more centrally placed.

The ureter and the pelvis in this group are always strongly involved this is to be expected whenever there is a pre-existing dilatation of the urinary passages.

Accompanying these lesions are often others which may be considered to be descending in origin the infecting agent having passed into the blood at the same time that it ascended by the more direct route.

**Diffuse renal suppuration**—This is the surgical kidney of chronic urinary cases and combines all the forms of renal infection previously mentioned. The lesions are almost always bilateral. The kidney is somewhat enlarged and presents a surface irregular with projections and depressions.

On section one sees patches of red plum coloured and greyish tissue arranged irregularly throughout the substance.

The cortex which is not easily distinguished from the medulla is atrophied and shows the presence of miliary abscesses which are arranged in striæ and scattered widely.

The papillæ are flattened and often eroded. The pelvis is dilated and contains purulent urine. The mucous membrane is thickened and has a granular surface.

The ureter is dilated lengthened and tortuous. The mucous membrane is reddened. The walls are sometimes very thick.

Microscopically one sees widely scattered lesions of sclerosis and tubular dilatation with which are associated inflammatory lesions characterized by foci of leucocytic infiltration and disintegration of renal tissue.

In short the lesions represent the changes seen in all types of renal infection. Dilatation and infection lead to sclerosis and prepare the soil for further attacks routes.



**Abscess and carbuncle of the kidney**—Sometimes though rarely, suppuration is localized to a segment of the kidney and leads to the formation of an abscess of varying size. Sometimes many small abscesses coalesce to form a large suppurating mass commonly called a renal carbuncle (Figs. 362 and 363). If left to discharge itself the abscess may open into the pelvis or perirenal tissue. In the latter case a perinephric abscess generally results.

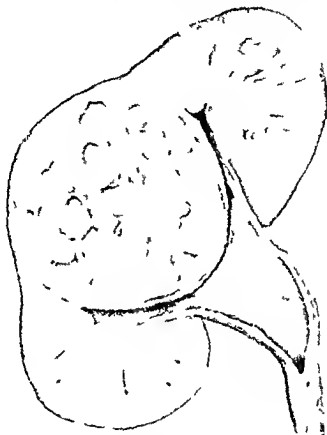


FIG. 363

**Renal Carbuncle**—The kidney of a man aged 24 who gave a history of three weeks' pain in his left loin. Eight months previously a perinephric abscess had been drained. Two months before he came under observation he had an attack of hematuria. On investigation his urine was found to be infected with streptococcus pyogenes aerius. A large swelling was felt in his loin. He had fever.  
(From Boll and Evans.)

**Chronic renal sclerosis**—The kidney is generally reduced in size, its surface is irregular though smooth and covered with a thickened opaque and adherent capsule.

On section one notes atrophy of the cortex, obliteration of the papillae, dilatation of the calyces and the pelvis.

Histologically there is diffuse sclerosis round the blood vessels and the tubules, the latter being dilated. The sclerosis is most marked in the cortex where the epithelial elements become gradually obliterated. This process can

lead to atrophy of a considerable part of the kidney, so much so that one may be led to believe that the condition present is one of congenital atrophy. Sometimes the sclerosis instead of being diffuse is limited to a part of the kidney.

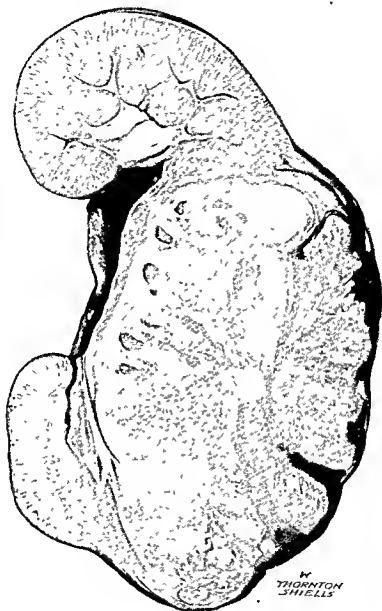


FIG. 364  
Nephrectomy specimen showing extensive caruncle: from a woman aged 33. (Sir W. Girdling Ball's case.)

**Lesions of the opposite kidney.**—It has been shown experimentally that in the presence of a unilateral renal infection the functional activity of the opposite kidney is reduced.

It is difficult to find an adequate explanation for this phenomenon. The hypothesis that a toxin from the diseased kidney enters the circulation and damages the other organ is the most acceptable one. This conclusion is based

on experimental evidence. The toxæmia has been shown to influence adversely organs other than the kidneys.

**Hæmatogenous infection**—In the early stages widespread multiple abscesses occur which in the early stages do not involve the medulla, pelvis or ureter. The infection is undoubtedly commonly bilateral although clinical evidence of this is not always forthcoming at the onset. Sometimes a number of small abscesses will fuse to form a carbuncle.

At times a triangular area of necrosis with its base towards the outer border and its apex towards a calyx will be defined. Such an appearance is most satisfactorily explained on the basis of a thrombosis in the renal vessel supplying the area.

Perinephritis in some degree is constant in these infections. On the outer surface of the kidney small abscesses are often apparent and explain the perinephritis. The bursting of the more superficial abscesses into the extrarenal tissues often leads to perinephric abscess.

*Staphylococcus* is the common organism found, aureus more often than albus.

Renal abscesses from coliform bacilli are decidedly uncommon. *Bacillus proteus ammoniae* has been reported as producing virulent renal lesions.

In the mild cases resolution occurs leaving scars on the surface and in the substance of the kidney.

Adhesions between the perinephric fat and the kidney are often the result of this process.

In typhoid fever granulations may develop in the ureter and pelvis and give rise to hæmorrhages. There may be local areas of healing while in other parts of the organ many small abscesses may coalesce to form either a large abscess or a carbuncle.

The suppurating process in the renal parenchyma may slowly extend from the cortex through the medulla to the pelvis where pyelitis results. Through the medulla the spread appears to follow the lymphatics in the intertubular spaces.

In renal tuberculosis which is in the great majority of cases blood borne the infection advances slowly and this gives an opportunity for determining the direction of the spread in the kidney. It is clear in this type of infection that the progress, direction and course of the spread are as indicated above.

In the very acute type of case the whole kidney is involved in a severe infection in the course of a few days the infection showing thrombosis of all the principal vessels and involvement of the perinephric tissue.

If the blood vessels are completely occluded the whole becomes a necrotic mass.

In the mildest cases of renal infection only a zone towards the periphery of the organ is affected which also involves the adjacent fat but the deeper parts of the organ and in particular the pelvis completely escape the infection.

If organisms are found at all in the urine at the outset they soon tend to disappear. Great care may be needed in investigating the urine for organisms for often the cocci do not respond to cultivation while they are easily identified in a stained smear.

**Ascending infection**—As would be expected pathological evidence of these cases in their early stages is hard to obtain so that many of the conclusions are based on evidence obtained from animal experiments. Kidney specimens obtained from cases of ascending infection which have terminated fatally do not have any distinguishing features from those where the patient has died with a hæmatogenous infection of the kidneys. The *B. coli* is often found to be the organism present in the pus taken from such kidneys.

The most obvious cases of ascending infection are those in which renal infection develops after catheterization. In spite of the most rigid precautions repeated catheterization will inevitably lead to infection of the bladder urine in a case of retention although of course there will not always be evidence of a spread of the infection to the kidneys.

It is in cases of retention from bladder neck obstructions of different kinds and of retention from disease or injury of the nerve control of the bladder that these occurrences are seen. The so called reflex retention of urine often encountered after surgical operations is not uncommonly associated with infection in the same way.

**ASCENDING INFECTION WITH OBSTRUCTION**—Theoretically it would be expected that the mechanism of upward spread in the presence of lower urinary tract obstruction would have an additional factor according to the degree of



FIG. 365

Excretory pyelograms showing mild dilatation of pelvis. A state of affairs which is commonly associated with chronic ureteritis or prostatitis.

obstruction present. For if this is severe then the organisms could simply pass up the distended ureters in the stagnant urine to the renal pelvis. Experimentally this process has been known to occur.

But there is more in the occurrence than this. For often the urine is completely sterile until it is drawn off by catheter after which it becomes infected and signs of pyelonephritis occur even though no retention subsequently exists. The most reasonable explanation of events in these circumstances is that the infection has travelled to the kidneys outside of the ureters but the devitalizing effect of the retention has prepared the kidneys as a medium suitable to receive the infection.

**THE URETERS AND PELVES IN ASCENDING INFECTION**—According to the degree of dilatation present so there will be retention of purulent urine in the pelvis and dilated calyces. A careful inspection of urograms shows that a mild degree of dilatation is often appreciable without any actual obstruction being present (Fig. 365).

Where dilatation has preceded the infection the lesions of the ureter are generally bilateral. There is dilatation, tortuosity and elongation in varying

degrees on both sides. These changes often add further obstructive elements. Microscopically the wall is thickened with fibrous tissue and there is round celled infiltration. It is in the cases of chronic urinary retention that these changes are seen.

When the infection has preceded any dilatation that may be present the changes are usually unilateral rather than bilateral and there is a well marked periureteritis extending from one end of the ureter to the other in addition to inflammatory changes in the wall of the ureter itself. The dilatation of the ureter may be very slight in this group of cases but it should be looked for in all cases of ascending infection.

The changes noted around and in the wall of the ureter are equally marked in connection with the pelvis. There is a tendency to dilatation in all cases the cavity contains turbid urine and debris from suppuration the mucosa is injected the wall is thickened and may contain plaques of leucoplakia in very chronic cases. According to the amount of inflammation present the pelvis is surrounded by a mass of adherent fibro fatty tissue which is also prolonged into the kidney round the calyces and blood vessels.

**PERINEPHRIC INFLAMMATION IN ASCENDING INFECTION**—There is no doubt that infection involves the true capsule of the kidney at an early stage. In a number of cases which have suffered from chronic renal pain associated with a focus of infection below the brim of the pelvis I have decapsulated the kidney for relief of pain. In no instance have I failed to observe thickening of the true capsule of the kidney doubtless resulting from a spread of infection from the renal cortex. Moreover the dramatic relief experienced is a result of this procedure in certain cases suggested a restricting effect by the capsule on the kidney. Further stages of the spread of infection to the perinephric tissues tend to occur in due course.

**Pyonephrosis**—The term is applied to a dilated kidney containing pus. A kidney in such a state is enlarged and its surface is covered with lobulations representing the dilated calyces. The colour of the organ varies from dark red to grey in proportion to the loss of renal tissue. The parenchyma is soft in consistence.

On section one observes the series of large rounded sacs due to a combination of stretching of the calyces and a replacement of the renal substance by fibrous tissue. These open by small and inadequate orifices into a thick walled pelvis which may or may not be appreciably enlarged. A fibrous deposit resembling a false membrane lines the calyces and pelvis in advanced cases in the others various degrees of pyelitis are seen. Pus is present in all the cavities diluted by whatever urine may be present. Active excreting tissue may still be present in which case it occupies the partitions which separate the cavities. When not present it is replaced by fibrous tissue and the microscope shows this to be infiltrated with leucocytes. It is unusual to find glomeruli or tubules in such tissues.

According to the state of permeability of the ureter the pyonephrosis is open or closed. On the other hand a pyonephrosis can be alternately open or closed.

The distension of the kidney may be due to an obvious obstruction or it may occur without any apparent cause as in some cases of hydronephrosis. It may be the late result of a chronic inflammatory process particularly of the ascending variety in which the ureter becomes narrowed or the seat of a kink which is fixed by adhesions. In such cases infection plays an important part in the aetiology from the beginning. Alternatively the kidney may be in a state of distension and remain free from any considerable degree of infection for a period of years before pyonephrosis occurs.

Once severe infection has supervened however abscesses form in the parenchyma which is already the seat of atrophy fibrosis and degeneration. The infection then spreads to the perinephric fat which undergoes in general a transformation into a marked fibrosis as a result of perinephritis giving rise to a fibro lipomatous mass which forms firm adhesions to neighbouring organs. The surrounding sclerosis involves also the pelvis the adjacent ureter and surrounding tissue and constitutes a peripelvis and periureteritis which help to increase considerably the thickness of the walls of these channels.

### CLINICAL TYPES OF RENAL INFECTION

**The hæmatogenous infections**—These may be divided into three types Fulminating acute and the subacute

**THE FULMINATING TYPE**—Clinically the condition is not often seen it occurs more conspicuously in male adults than in females or children

The effect of the infection on the patient may be severe at an early stage. The initial stages are quite likely to appear with a rigor upper abdominal pain nausea vomiting distension and collapse. The temperature is usually sharply raised the pulse rapid and there is a falling off in urinary excretion. A peripheral septic focus such as a boil will probably be found. The clinical picture may suggest an acute abdominal lesion especially as there is generalized abdominal pain and tenderness.

The abdominal symptoms are the result of widespread retroperitoneal changes which often accompany kidney lesions. The abdominal distension and vomiting are apt to distract the attention from the urinary to the intestinal tract. Leucocytosis is always a marked feature. To further direct ones attention from the urinary tract there are no urinary symptoms such as frequency or dysuria but the urine should be searched carefully for cocci. These may be missed if a culture only is used but a stained smear will always reveal them. It is usual to find a trace of albumin.

**ACUTE INFECTIONS**—These have the same physical signs and symptoms as described in the fulminating type but less in degree.

As the patient is more alert than in the severe form costomuscular and abdominal tenderness are more easy to elicit and in this group it should be a simple matter to determine whether one kidney is more involved than the other as is often the case.

The absence of any striking evidence of disease in the urinary tract is again a feature and one emphasizes the probability in the early stages of missing evidence of infection in the urine. Within the first week cocci should be found after searching by the approved method but if the investigation is made after this period has passed this evidence may have disappeared.

The sluggish course of the infective process in the kidneys is often apparent from the recurring chills and irregular fever over an indefinite period.

The kidney is always enlarged and unless the patient be corpulent or muscular is obvious on palpation. The tenderness is of course appreciable even though the kidney cannot be felt and is indicative of perinephritis which is present in all these cases.

An inquiry as well as a search should be made for a peripheral lesion in children in particular tonsillitis dental abscess otitis media and osteomyelitis may initiate the renal infection.

Pus may not be found in the urine for several weeks after which period it begins to appear and during this time the suppurative process in the kidney may well have resolved itself into a localized abscess or a carbuncle by a

fusing of a number of small abscesses or necrosis of a portion of the kidney due particularly to thrombosis in the vascular supply to that particular locality.

A watch should always be kept for suppurative perinephritis. The tenderness becomes more superficial in the loin where in due course a slight bulging is noticeable when the patient sits up and leans forward. As the condition advances a plain X ray shows obliteration of the psoas margin and slight scoliosis with concavity towards the affected side. An intravenous urogram is quite likely to show some of the opaque medium collected in the perinephric region. If surgical intervention is postponed long enough oedema and even redness of the skin of the loin will be seen. (See also Perinephric Abscess.)

**SUBACUTE TYPE**—The symptoms are not pronounced and their origin may easily be overlooked. There is general ill health with backache and only moderate fever. leucocytosis is not marked and the urine remains free from pus unless examined in the first few days of the illness when cocci may be found.

In searching for an explanation of the patient's condition a peripheral inflammatory state such as a chronic tonsillitis may be considered to be the explanation without appreciating that a kidney complication exists. The ache combined with tenderness which is always present in the loin in some degree in these cases should make the kidney condition obvious.

**BACILLARY HÆMATOGENOUS INFECTIONS**—From a clinical point of view bacillary infections of the kidney differ from those due to cocci in that the onset and course are more insidious and the condition tends to settle into a more chronic state. Any of the clinical features seen with the coccal infection may be present but are less pronounced and may even be absent. It is an interesting speculation why this should be so.

The three chief groups of organisms which one has in mind are coliform, typhoid and tubercle bacilli. In the days when typhoid fever was more common about a third of the cases would have B. typhosus in the urine with pyuria and with little other evidence that the urinary tract was involved. With renal tuberculosis it is quite usual to note an absence of subjective symptoms relating to the kidneys.

**Clinical types of ascending infection**—Infection spreads to the kidney much more commonly by ascent than through the blood stream. The importance of locating the primary focus is obvious from the point of view of treatment.

Clinically the spread of infection by the ascending route may be assumed when renal infection exists in the presence of retention of urine in the bladder and it may be strongly suspected although the renal infection is not accompanied by retention when the presence of a focus of infection in or in the vicinity of the lower urinary tract is known to exist. Disturbances of micturition which are so often present in the latter circumstances certainly support this point of view.

**ASCENDING INFECTION WITHOUT RETENTION**—These cases are seen more commonly in women and children than in men. We will consider the cases under the headings acute, subacute and chronic.

**Acute type**—In these cases there may be a sudden onset of painful and frequent micturition often with hæmaturia. The last symptom is generally more particularly terminal in relation to passing water. The blood comes from the bladder.

This type of onset is in sharp contrast with what occurs in the opening phase of a hæmatogenous infection. However nausea vomiting a falling off of urinary excretion generalized abdominal distension and tenderness will also occur if the degree of infection is sufficiently severe.

These acute symptoms frequently occur in a case that has suffered from

previous acute attacks or chronic frequency of micturition. After the acute condition has settled investigation invariably reveals the chronic focus which precipitated the acute attack. This will be found either in the urethra or in connection with the genitalia.

From the onset of the micturitional symptoms the urine contains pus organisms—generally coliform bacilli—and of course albumin. Neither rigors nor pyrexia are common in the initial stages and when these occur they are generally a sign that renal infection by ascent has occurred. This change is manifested by renal tenderness which is often more marked on one side than the other. In due course there is generally evidence of enlargement of the kidneys. On the whole the course of the illness is shorter and less stormy than is seen with the blood borne infections.

The renal infection in most cases will clear up completely when the acute attack is settled. In others the patient is left with a mild chronic infective process in one kidney or in both kidneys as indicated by coliform bacilli and a variable number of pus cells in the ureteric catheter specimens.

Other cases are left with an intermittent ache in one loin or in both loins even though no evidence can be found by ureteric catheterization that an infective process is going on in the kidney.

In severe cases the fever progresses the urinary excretion falls the patient sinks into a lethargic state and gradually deteriorates and death supervenes.

*Subacute type*—Cases in this group necessarily show a difference in degree of the clinical features just discussed.

There is chronic bladder irritation, general malaise and a tendency to tire easily. Aching in one loin or in both loins is usual. Pyrexia is mild and intermittent. There is often a tendency to polyuria rather than anuria. The urine contains pus and coliform bacilli.

*Chronic type*—This may result from one of the foregoing or its onset may have been insidious over a considerable period. There are present chronic disturbances of micturition with evidence of some degree of infection in the urine. Polyuria is not uncommon. In the mildest type the urine may appear quite clear on naked eye examination while the bacteriological investigation shows but few pus cells and a coliform or a mixed type of infection. Ureteric catheterization may provide evidence of unilateral infection or of a much more pronounced infection on one side than on the other.

The patient complains not only of aching in the loins but generally also of rheumatic pains in various parts of the body particularly in the lower part of the trunk.

The rheumatic manifestations may be regarded as due to the chronic pelvic foci which are the primary cause of the illness. General ill health with lassitude, hyperpnea, headaches, constipation and flatulence is also to be expected. Acute attacks of cystitis and pyelonephritis from time to time are a feature of these cases.

The prognosis without early and adequate treatment is one of slow but steady general deterioration. The features of the case may ultimately be those enumerated below under *Ascending Infection with Retention*.

Intravenous urography shows the following features —

- 1 Persistence of poor definition in certain groups of calyces
- 2 Slight dilatation of the renal pelvis
- 3 The ureter especially in the upper part is slightly dilated and often a little tortuous

The above changes may also be noted in the two preceding types.



**ASCENDING INFECTION WITH RETENTION**—In the majority of cases there is an obstructive condition at the bladder neck therefore this type of case is found more commonly in men. The amount of retention may vary from a few ounces to several pints. The retention may be complete or the patient may still be able to pass some water in spite of chronic retention.

In the male *changes in the prostate* after middle life provide the commonest group. But there are many other cases which occur in both sexes in earlier life and which seem to be due to a fibrous process which tends to constrict the internal urinary meatus. Removal of some of the tissue with the electrotome and subsequent microscopy commonly reveal an inflammatory process.

Then there are cases of *urethral stricture* the advanced states of which are always accompanied by a fibrous constriction of the internal urinary meatus also inflammatory in origin.

Next there are cases which develop retention following operations. These are sometimes referred to as reflex retention but where the complication has arisen following an operation in the vicinity of the bladder as for example after a panhysterectomy it is probably the result of congestion involving the internal urinary meatus or more broadly a derangement of the mechanism of micturition as a result of the disturbances of adjacent structures.

Finally there are cases of retention of urine following interference with the nerve control of the bladder from disease or injury of the nerve mechanism.

Sometimes the renal infection develops insidiously there is polyuria the urine is pale and contains a small quantity of albumin the temperature may have a tendency to be subnormal or it fluctuates slightly or widely in relation to the normal the patient tends to become lethargic the appetite is poor food produces nausea only fluids are acceptable thirst becomes prominent the tongue is dry red and dirty. Accompanying these signs is a loss of weight dry skin and a falling off in urinary excretion flatulence often gives way to looseness of the bowels and dyspnoea develops as the end approaches. The early stages may extend over some years but the ultimate prognosis is always bad. The above signs are referred to as *uræmia*.

If a bladder infection has preceded the onset of renal infection the latter complication will probably be heralded by an increase in the bladder symptoms and of pus in the urine. Pyrexia rigors and renal tenderness are all likely in this event. Of course this train of events can supervene without a pre-existing infected bladder urine. The passing of a catheter to relieve retention is quite likely to be the precipitating cause. Any marked elevation of temperature or blood urea will make it certain that renal infection has supervened. Once infection has occurred in a case of chronic retention and has spread to the kidneys it may be quite impossible to arrest the progress of the disease which may go steadily from bad to worse. The change in this respect has a very decided relationship to the degree of retention especially where it comes to the state where the ureters are dilated from back pressure. One might say that in such a case the soil has been thoroughly prepared for the sowing of the seed of infection. Rigors remitting pyrexia and rapid pulse and a lethargic state may be the course of events hurrying rapidly to a fatal issue.

Surgical intervention of any kind directed towards relieving the retention succeeded by ascending pyelonephritis must be recorded as a common cause of death in these bad cases of urinary obstruction.

Obstruction of the ureter at the uretero-pelvic junction leads to the same kind of consequences to the kidney from infection as obstruction to the bladder neck. The after effects of passing instruments fall into the same category the interference in this respect may go no further than urethral instrumentation.

although when ureteric catheterization is added the consequences may be even more dramatic. The use of intravenous urography as a final measure in investigating hydronephrosis should save many a patient from serious cystoscopic reactions.

### SPECIAL TYPES OF INFECTION

**Childhood—HÆMATOGENOUS INFECTION**—In childhood this mode of renal infection is sometimes dramatically illustrated as a result of such infective foci as septic tonsils, dental abscess, respiratory tract infections, etc. In such cases hæmaturia may be the outstanding manifestation of the urinary tract infection.

**ASCENDING INFECTION**—It is a well established fact that female children are more liable than males to urinary tract infection with the colon bacillus. In infancy this discrimination between the sexes does not exist, as the infection occurs in about the same proportion in male and female.

In many children a clue to the origin of the urinary tract infection is apparent on inspecting the external genitals. In the female a condition of simple vulvitis (Fig. 125)—often seen to be involving the external urinary meatus—is sometimes manifest. In the male, atresia of the external urinary meatus may be obvious, especially in circumcised children, who often have meatitis with or without atresia. In others there is balanitis or adherent prepuce with retained smegma (Figs. 126–131).

Quite logically it has been assumed that the female urethra more readily admits infection than does the urethra of the male. It is difficult to think of any other explanation of the greater incidence in the female of urinary tract infection and certainly no other has been forthcoming.

There is a temptation to assume that the bacteria merely pass by way of the urethra without interruption into the bladder, but cysto-urethroscopic investigations of children with infected urine or simply with disturbances of micturition, show that it is common to find chronic infective foci particularly in females in the urethra. Spence and Moore (1939) found these foci particularly common in children who had suffered from pyelitis.

The symptoms vary considerably according to whether the case is acute or chronic. The acute case begins with painful and frequent micturition, after a few days there is often hæmaturia, this is generally terminal in relation to micturition, a few drops of blood being voided with a good deal of pain for a day or so, an increase in the pyrexia and the gradual development of abdominal pain indicate a spread of inflammation to the kidneys.

Occasional vomiting and some looseness of the bowels may develop. The urine contains pus and coliform bacilli. In some cases evidence that the upper urinary tract is involved may be lacking, and at the end of the illness the clinician may still be in doubt as to the extent of involvement of the urinary tract. During the acute stage no instrumental investigation is justified to settle this academic point.

In due course the symptoms and signs usually subside, even to the extent that pus and organisms disappear from the urine. In other cases the urine remains infected, the latter state of affairs calls for investigation by cystoscopy and X-rays.

In the purely chronic and the more subacute type of case painful and frequent micturition may be entirely absent, the patient simply manifesting poor general health and a mild form of fever, and the first evidence of the seat of the trouble is found on examining the urine. In these cases it may be difficult

to elicit any renal tenderness but urography and cystoscopy will reveal the presence of a low grade pyelonephritis.

These methods of examination must be pursued also for the purpose of determining whether there is any abnormality in any part of the urinary tract which would explain the tendency to chronic infection. Dilatations with or without obstructions are the usual causes.

**CONGENITAL ABNORMALITIES.**—Mechanical obstructions may occur in any part of the urinary tract from the orifice of the prepuce upwards. Extreme phimosis because it is so obvious is not likely to be allowed to persist for long.

Atresia of the external urinary meatus may not be noticed so readily especially as in some cases the condition develops insidiously after circumcision. Congenital stricture of the urethra generally in the penile portion occurs from time to time and may easily escape detection. Valves in the posterior urethra are extremely rare and can be identified with certainty only by endoscopy.

Varying amounts of vesical retention often with only small amounts of residual urine and resulting from even mild degrees of obstruction at the internal urinary meatus are not so uncommon and are frequently overlooked. In the extreme degrees of this condition there is dilatation not only of the bladder but of the ureters and kidneys as well.

At the ureteric orifice ureterocele has to be kept in mind as a cause of obstruction.

Stricture may occur at any part of the course of the ureter. Its commonest site however is at the uretero pelvic junction thus producing hydronephrosis. A rare condition is where the outlet of a calyx is constricted giving rise to the condition known as hydrocalycosis (Fig 32). Other causes of obstruction are compression of the ureter between the pelvis and a renal blood vessel and stone in any part of the urinary tract (Fig 40).

Any of the above conditions occurring in the upper urinary tract may be bilateral.

Dilatation of any part of the urinary tract from the bladder upwards may occur without any obstructive cause which can be identified (Fig 366).

**URINARY INFECTIONS OF PREGNANCY AND THE PUERPERIUM.**—The term pyelitis is often used loosely in reference to cases falling into the above category without accurate information as to whether the infection is seated in the kidney or not. Often there is no indication that the infection has ascended above the bladder.

In the great majority of cases the infection manifests itself during pregnancy a small proportion only developing during the puerperium. The signs of infection become obvious more commonly during the fifth and sixth months than



Fig 366

Mild but definite dilatation of the right kidney and ureter. Intravenous urogram in a girl of 11 years who suffered from attacks of right sided pyelitis.

in any similar period throughout the pregnancy, but in primipara the infection tends to occur earlier and to be more severe than in multipara. Most of the cases occur during the first and second pregnancies, the incidence becoming successively less in the succeeding pregnancies.

In the great majority of cases both the symptoms and signs of infection in the urine have disappeared within two weeks of delivery.

The colon bacillus is the commonest organism, and the staphylococcus the next.

The routine use of excretion urography has resulted in regular observations being made on the urinary tract, in many series of cases. These have shown that the dilatation occurs in 100 per cent on the right side, and in from 70 to 85 per cent on the left.

The dilatation is greatest in the first pregnancy but begins and reaches its maximum earlier in multipara than in primipara. According to Kretschmer, Heaney and Oekuly (1933) the dilatation disappears after delivery during a period extending from two to twelve weeks.

The dilatation of the ureters apparently results from the excretion of estrin and corpus luteum hormone. The excretion of these substances increases throughout the pregnancy from the third month onwards. MacLean and Deming (1943) have shown that the incidence of pyelonephritis runs parallel with the incidence of dilatation of the ureter and that both run parallel with the increased excretion of estrin and corpus luteum hormone in the urine as pregnancy advances.

It would be difficult to deny that the tendency to stasis from the dilatation is an encouragement to the onset of infection. On the other hand we must seek for the causes which determine that infection supervenes in only a small percentage of cases, for Crabtree (1929) in reporting on 7,726 deliveries found only about 2 per cent were complicated by pyelitis during either the pregnancy or the puerperium.

Personal observations of many cases drives one to the conclusion that the initiating causes of pyelitis are the same in the pregnancy as in the non pregnancy cases. This view has been expressed from time to time by others. Howard Hanley (1945) has published figures relating to 200 consecutive cases of *B. coli* pyelitis in women of child bearing age. These contrast the predisposing causes in 100 non pregnant, with 100 pregnant women, and indicate that in both groups urethro trigonitis plays a prominent part, and that broadly speaking the other causes are the same.

My personal observations of cases of pregnancy with infected urines have in a large number detected an infected condition of the cervix—generally in the form of an erosion—or a chronic inflammatory focus in the posterior urethra and at the bladder neck (urethro-trigonitis). In the minority were the cases of chronic nephritis, hydronephrosis or stone or tuberculosis of the upper urinary tract. In the last group it was generally the case that the pregnancy called attention to these unsuspected conditions. Another group of cases is where the urinary tract infection is secondary to some previous disorder—especially inflammatory—of the reproductive organs. A previous history of a miscarriage—particularly of the induced variety—is perhaps the most important of these.

Often there is no clinical feature which establishes the fact that the infection is seated in the kidneys, and ureteric catheterization may fail to offer proof that it has ascended above the bladder. There seems no reason to regard these cases as other than those of infection involving some part of the reproductive apparatus or the urethra and trigone, which have been flared up by

the pregnancy and puerperium and which may or may not involve the kidneys by ascending infection.

The clinical picture may present at the one extreme a case in which there are no symptoms at all except possibly some mild frequency of micturition and in which the urine is found to be infected while at the other is a severe acute condition with marked constitutional symptoms. The course of the disease does not differ in essentials from that taken by urinary tract infection occurring under other circumstances except that in certain cases severe renal damage results. As a rule the alarming symptoms subside in response to mild conservative measures.

**Infection following operations on the kidney**—Evidence that this has occurred will cause no surprise if the operation is undertaken in the presence of a well established renal infection. But renal infection may occur when no such predisposing cause exists. It may complicate any operation in which the kidney is opened especially when the renal substance rather than the pelvis is incised as is frequently done for removal of stone.

There may be the sudden onset of high fever with the upper abdominal and constitutional signs already referred to under acute renal infections. With such features the surgeon will be faced with the problem of having to decide whether he should intervene at once and remove the kidney. He is faced with the difficulty that events may shape themselves favourably under conservative measures but that if this is not going to occur the patient's chances of recovery largely depend on the promptitude with which nephrectomy is carried out.

The post operative infection may show itself as a prolonged and remitting pyrexia which, as a rule finally settles satisfactorily without surgical intervention.

It is important in all cases in which the kidney has been opened to fix a rubber drain to the site of the renal incision.

**Renal inflammation from medicinal substances**—This group requires special mention because it may be in the course of treatment of a urinary tract infection by medication that evidence of this complication arises.

Pathologically the kidneys show the lesions of acute nephritis.

There is lumbar pain and often oliguria or even anuria. The urine contains pus, red blood and epithelial cells. When the urinary excretion is not appreciably reduced there is generally frequency and dysuria. According to the length of time the condition has been present, so there is some danger of chronic nephritis.

The symptoms generally disappear promptly under the appropriate treatment which consists in eliminating the medicine in question and giving copious fluids and a light diet.

The sulphonamide group of drugs especially when given in large doses are the most important causes of this complication. The renal tubules and pelves and the ureters may be choked with the precipitated crystals of the substance in question. Sulphapyridine has been reported as the worst offender but sulphathiazole and sulphadiazine are not free from blame in this respect. It may be necessary to carry out nephrostomy if the case does not yield to conservative measures.

### THE DIAGNOSIS OF RENAL INFECTION

Undoubtedly some cases of renal infection go unsuspected. A general physical examination even though carefully conducted may fail to reveal the true state of affairs. More often than not one symptom more than another

attracts attention and according to the nature of this manifestation it may be attributed to some other cause. Such mistakes are common with both acute and chronic cases. Chronic dyspepsia, disturbances of the bowels, rheumatism, headaches, hyperpæsis, lassitude and a tendency to sleep at all times often have their origin in a chronic urinary infection.

The detection of even a slight degree of *tenderness* in the costo-muscular angle should at once put the clinician on the right track. This discovery is particularly important in an acute case which simulates an intraperitoneal lesion. It is equally true of both pain and tenderness that they are regularly present in acute cases but often absent in chronic ones.

*Pain* is usually aching in character. In the acute cases this is severe, in the chronic cases this symptom is often intermittent. The more acute the infective condition is the more is the pain distributed widely in the upper abdomen so that in the fulminating type some intraperitoneal crisis in this



FIG. 367

Cystoscopic view showing dilatation of both ureteric orifices and chronic inflammation on the back and to a less extent on the front of the trigone. The changes at the ureteric orifices indicate chronic pyelitis.

part may be simulated. Sometimes the pain is widely referred, as is the case with colic, to the groin, genitals, thigh, etc. In this respect it is not characteristic of infection, but is common to other pathological renal conditions.

*Abdominal distension, constipation and vomiting* occur in severe cases. The patient's mental condition is quite likely to be confused.

*Instrumental investigations*, especially of the urethra and bladder neck, are essential in some cases, as they quite commonly give the clue to the renal symptoms. It is important to remember, however, that no instrumental investigation is indicated in cases of acute infection, and that there are some cases of chronic infection where instrumental investigation is likely to do more harm than good, and should be omitted. In certain cases therefore, it will remain in doubt whether the infection is localized to the bladder or whether it involves any of the upper urinary tract as well.

Cystoscopy shows alterations at the ureteric orifices (Fig. 367). Ureteric catheter specimens of urine give opportunities for discriminating between the conditions prevailing in the two kidneys. The excretion of indigo carmine observed during the cystoscopy at once gives a good idea both of the total renal function and of the function of one kidney as compared with the other.

Observation of the condition of the urine as it is expelled from the ureteric orifices may also give valuable information

Once pyelonephritis is recognized it must at once be decided whether it is tuberculous or not. As a rule a sound opinion can be formed at once on this point from the cystoscopy, but where doubt exists the urine must be exhaustively examined for tubercle bacilli.

The urine—*Polyuria* is present in a large number of cases especially in the early stages.

Reliable observation on the urine requires that the collection and examination of the urine be carried out with due care. The urine must have been freshly collected under sterile conditions. In the male it will suffice if the patient passes first a small portion which is discarded and then the specimen for examination into a sterile bottle. In the female a catheter must always be used. This applies equally to female children. Before passing an instrument the vulva should be wiped with a swab moistened with antiseptic and then with a dry swab.

The usual chemical examination is first carried out. In a marked proportion of cases of hæmatogenous infection apart from a trace of albumin the ordinary urine examination will result in a report that the urine is negative. In this particular type of case however the greatest help should be forthcoming from an examination of the urine in the early stages but this assistance may not be available unless certain precautions are taken. These consist in thoroughly centrifuging the urine and then examining the stained deposit rather than relying on culture for although cocci are present they often will not grow on ordinary culture media. Cabot advises that the centrifuging should be done at high speed for thirty minutes when the urine is apparently normal. After four to six days in a hæmatogenous infection the cocci tend to disappear so that a urinary investigation may fail just because it has been done at the wrong time. Where pyuria is present the pitfalls I have mentioned hardly arise as the bacteria in these circumstances are usually easy to identify.

The absence of any renal symptoms still leaves the clinician in doubt as to whether the infected urine indicates a renal or merely a bladder infection. This point can often be settled only as a result of an instrumental investigation. In acute cases such a procedure is definitely contraindicated and an investigation of this kind if necessary at all must be left until all acute symptoms have subsided.

**Pyelography**—**INSTRUMENTAL PYELOGRAPHY**—Since the discovery of intravenous urography the instrumental form of this radiographic examination is very seldom necessary and in most cases there is no justification for employing the procedure. Certainly it would be quite unwarranted to practice it in the presence of an acute infection and even with a chronic infection there is always the danger of flaring it up into an acute state.

Another disadvantage of this method is that it does not give a true picture of the ureter as the passage of the catheter prevents detection of the minor tortuosities of this channel. This is an important matter with regard to chronic inflammation because in this condition the ureter often becomes a little hypertrophied and thus somewhat lengthened as well as dilated. Also this method fails to show the irregular outline of the renal pelvis which often results from chronic pyelitis.

When a series of excretion urograms fails to give a clear impression of the condition of the kidney in certain cases the instrumental procedure will be indicated. The intrarenal pressure which results from the injection of the fluid with the syringe has the advantage of demonstrating the presence of

*Urinary antiseptics of the sulphonamide group* (see p. 767) should be given with considerable caution. They certainly should be withheld in the presence of renal failure.

For medicinal treatment see p. 763.

**The administration of fluid—BY THE MOUTH**—Large quantities of fluid should be taken daily. Barley water for preference (see p. 764) but ordinary water need not be despised in the absence of the former. Weak tea, milk and water and lemon drinks are also efficacious and may be used as alternatives to lighten the task of steady drinking. The exercise of this important principle helps considerably by diluting toxins and encouraging their elimination from the kidneys. An intake and output chart should be carefully kept as this shows at a glance not only the amounts taken and excreted but indicates at once whether or not there is any renal failure.

Generally between 80 and 120 oz. of fluid (200 and 3400 cc) should be taken in the twenty-four hours. As the patient improves so the amount may be steadily reduced. When the patient is too lethargic to take by the mouth or vomiting is present the fluid must be taken by other methods which are discussed below. In the presence of vomiting it is sometimes gratifying to see how effectively this symptom can be brought under control by skilful fluid administration.

**SUBCUTANEOUS FLUIDS**—When drinking is impracticable the subcutaneous method is perfectly effective and is simpler and often less dangerous than the intravenous method and need only be continued until such time as the patient is able to resume taking fluid by the mouth.

At least two needles should be inserted into different subcutaneous areas and the drip so regulated that no swelling of the tissues is allowed to occur. The dripping of the transfusion should be regulated to about 30 to 40 drops per minute. It should be made even slower than this if absorption is not keeping pace with the inflow as indicated by local oedema. If it is necessary to continue this method for twenty-four hours or more the locality of the injection should be changed more than once during the period of administration.

Normal saline should be used. Glucose is irritating to the tissues.

**INTRAMUSCULAR FLUIDS**—This method while being as equally simple as the above to administer offers this advantage that absorption is quicker from a muscular than from a subcutaneous zone. The same supervision must be exercised with regard to the rate of drip.

A 2 or 3 in. needle is entered obliquely into the outer aspect of the thigh in the upper third until the point touches the femur. The needle is then withdrawn for a fraction of an inch and fixed to the thigh with adhesive plaster.

**INTRAVENOUS FLUIDS**—The intravenous method requires much more supervision and care than the subcutaneous or intramuscular. This applies particularly if there is any evidence of renal failure for if more fluid is introduced into the veins than can be dealt with by the kidneys it will be an embolus rassment to the heart and collect in the tissues and cause oedema. The kidneys will share in this state and thus their functional activity will be further impaired.

The lack of due care in the intravenous administration of fluid carried sufficiently far will lead to the death of the patient and the reason for this will be obvious on the post mortem table in the widespread oedema of many of the viscera which will be revealed there.

It is essential when administering fluid by this method to make frequent observations on the amount of fluid excreted by the kidneys in relation to



the intake Any evidence of renal failure calls for very slow administration which must be discontinued if renal function is not quickly improved It would be wise to abandon this method if 10 oz administered over two hours is not effective in improving the urinary output

It is useful to remember that even in the absence of signs of renal insufficiency a slow rather than a rapid administration is always advisable Forty drops a minute will average about 20 oz (550 c c) in four hours and this rate is quite fast enough Two pints administered in this way may find the general condition sufficiently improved for the patient to resume taking fluids by mouth Sodium sulphate (4.3 per cent) has a reputation for diuretic action in these cases

**FLUIDS BY THE RECTUM**—Only in special circumstances is this a satisfactory method of administering fluid The difficulty is that the patient often does not retain the fluid The occasion on which this method is eminently satisfactory is when the patient has just returned to bed after a general anæsthetic If the opportunity is seized and the saline is run in at once it is usual for an injection of 20 oz to be retained If however there is a delay of half an hour or so before the injection is made that is to say when the patient is beginning to come round from the anæsthetic either a part or the whole of the injection will be rejected by the patient This tendency is even more marked in a fully conscious patient and it is usually inadvisable to waste time with the procedure

**Pelvic lavage**—This is carried out through a ureteric catheter and gives benefit in certain chronic cases especially in females in whom it is more easily performed than in males and in whom there is less danger of an unfavourable reaction from the instrumentation It should be reserved for cases with dilated pelves in this respect it is often beneficial to eubacutic or chronic cases of pyelitis of pregnancy

The bladder should be filled with normal saline rather than an antiseptic This is because a fairly concentrated solution is generally used for washing out the pelvis and this might set up cystitis if antiseptic were used with which to fill the bladder From 5 to 10 c c may be injected at a time Silver nitrate has a well founded reputation as a eutablic substance for injection

Injections may be repeated at weekly or fortnightly intervals in gradually increasing strengths from 1 in 1 000 up to 5 per cent Collargol and argyrol are also beneficial Pain and fever as a reaction to the treatment must be expected if the treatment is carried out at short intervals

On the whole it is better to keep to the weaker strengths of silver nitrate say 1 per cent In this way larger quantities can be used and with less pain

The instillation has the effect of increasing the activity of the pelvis and encouraging desquamation of the pelvic epithelium

The injection should be given into the pelvis very slowly for fear of setting up colic from over distension

**Hæmatogenous infection**—In this variety as in the great majority of cases of renal infection treatment consists in the first instance of conservative measures As far as surgical intervention is concerned *nephrotomy* usually is an unsatisfactory measure An exception may be made if a localized abscess is present This is a difficult condition to diagnose but may be discovered at operation Sometimes in draining a perinephric abscess the exploring finger may locate a single necrotic area in the kidney which is easy to evacuate and drain

*Nephrostomy* is advisable in certain cases where the infection is associated with retention in the kidney sometimes as a preliminary to nephrectomy

*Nephrectomy* should be reserved for cases which are unmistakably unilateral and of the fulminating type cases which are progressive in spite of a fair trial of conservative treatment and cases where renal retention is present

In discussing the routes of invasion of the kidney we have referred to the fact that there is good reason to feel that the kidney sometimes becomes infected through the blood stream following urethral instrumentation. Nephrectomy is often the treatment indicated in unilateral cases of hæmatogenous infection but when the renal infection occurs following urethral instrumentation nephrectomy is indicated only when a unilateral pathological state pre-existed conservative measures entirely are indicated

In hæmatogenous infection from other sources it is largely accepted that in the cases mentioned above nephrectomy is the treatment of election when the infection is unilateral. A large body of opinion is in favour of nephrectomy in the majority of cases. As opposed to this radical view is the experience of many others that the condition often subsides without surgical interference. In addition there is always the possibility that the infection may involve the remaining kidney—a real disaster should this occur. On the other hand the speedy elimination of the infective focus with the prospects of a fairly quick convalescence is sometimes a justifiable expectation. This is in contrast to the prolonged illness from conservative measures to say nothing of the continued danger that the other kidney may become involved from the existing renal infection.

There is no doubt that where the condition is hæmatogenous in origin and where there is evidence of suppuration in the kidney which shows no sign of subsiding after a reasonable trial with conservative measures nephrectomy should be carried out. It is therefore essential to first eliminate the possibility that the renal condition is the result of ascending infection from the lower urinary tract or the reproductive organs for should this eventually turn out to be the case the patient will be indeed fortunate if bilateral infection does not ultimately supervene.

In coming to a decision on this point it is not enough to discover that the patient has or recently has had some subcutaneous infective lesions. I have experienced a number of such cases where a careful investigation has revealed an unsuspected prostatic infection. In such circumstances there is the probability that both the subcutaneous and the renal infection are secondary to the prostatic condition and herein lies the danger of ascending infection to the other kidney.

In all the circumstances if renal suppuration has gone on to a perinephric abscess the loin must be incised and the abscess drained.

We may usefully bear in mind that widespread staphylococcal abscesses are a well known complication of urethral instrumentation under certain conditions and it is not unreasonable to believe that these may occur independently of instrumentation.

**FULMINATING HÆMATOGENOUS INFECTION**—If there is any degree of certainty in the surgeon's mind that the condition is unilateral then prompt nephrectomy should be undertaken. Any tenderness in the costo muscular angle of the opposite side at once contraindicates operation.

**ACUTE HÆMATOGENOUS INFECTION**—In this type of case it is better not to rush into operation. Early intervention often reveals no more than widespread tiny abscesses scattered about the surface of the kidney which certainly is not a sufficient reason for carrying out nephrectomy. If one had waited this condition might quite easily have subsided or contrarily may have developed into a more definite indication for operation. Moreover too

lead to pyelonephritis and death unless prompt steps are taken to deal with the distended bladder. The best treatment is the early establishment of permanent suprapubic drainage.

Although pyelonephritis can occur in spite of the most scrupulous observance of aseptic principles in relieving retention of urine, strict attention to these rules must never be relaxed.

**Acute pyelonephritis without retention**—The patient should certainly be confined to bed. The outstanding feature in the medication should be the administration of liberal quantities of fluid (about 5 pints in twenty four hours).

Frequency of micturition is generally an accompaniment of these cases because cystitis usually precedes the renal infection. The bladder symptoms are often very distressing at one stage, when there may be not only great frequency but dysuria and terminal hæmaturia as well.

The cystitis calls for local treatment not only to relieve the patient's distress but because of the beneficial effect that may reasonably be expected on the course of the renal infection. A hypodermic injection of  $\frac{1}{2}$  gr of omnopon or a suppository of morph hydrochlor, gr  $\frac{1}{4}$ , and ext belladonnæ alc, P B '98, gr  $\frac{1}{2}$ , will give temporary relief from the discomfort. Washing the bladder out with 2 per cent boracic lotion, even on one occasion only, often has a dramatic effect on the course of the illness, benefiting both the vesical and the renal infection. The vesical lavage may with advantage be repeated daily for about a week. The principles already laid down with regard to diet and bowels should be followed. For medicinal treatment, see p 769.

If the temperature does not react favourably to the measures employed, investigations must be undertaken to see if some complicating condition such as pyonephrosis is present. An intravenous urogram is generally indicated as the first measure.

As far as the future is concerned if the predisposing cause of the infection is not obvious it is important that when the patient has recovered from the acute illness a thorough investigation should be carried out, especially with regard to the genital organs and urinary tract, with the object of finding a chronic focus. This is particularly necessary with a view to controlling a tendency to future attacks and a state of chronicity.

**A kidney, the seat of retention and acute infection**—The nature of treatment will depend on The amount of renal dilatation, the degree of infection, the state of the other kidney and how ill the patient is. It is a matter of experience that rest in bed and plenty of fluids generally cause the pyrexia and other acute symptoms to subside. Therefore it is wise to institute immediately this expectant treatment, while suitable medicinal remedies may be added. If the patient's condition begins to deteriorate in spite of these measures then generally surgical procedures will be necessary.

In the lesser degrees of dilatation ureteric catheter drainage is often efficacious in this direction provided that the catheter can be made to enter the renal pelvis. The catheter may be left in position for several days. On the other hand the instrumentation may have the opposite effect to that desired, and make the patient worse. This applies particularly if the catheter tends to become blocked. If this difficulty arises the catheter must be removed forthwith.

Unless the degree of dilatation of the kidney is only slight, relief of any obstruction which may be present will not result in a cure of the renal infection. In fact such a kidney will not only remain in a state of chronic infection but will be subject to acute attacks from time to time and be the cause of chronic ill-health.

If the condition is advanced the kidney will be in the form of a sacculated

dilatation containing urine and pus from which drainage is quite inadequate. The kidney has now reached the stage which would be properly described as a pyonephrosis and surgical interference becomes essential.

If the state of the opposite kidney permits it and there are no other important contraindications then nephrectomy should sooner or later be carried out. Sometimes it is wise to establish nephrostomy first. This may be necessary if conservative measures fail to allay an attack of acute infection because a large pyonephrosis is present or if the general condition of the patient contraindicates nephrectomy. Care must be taken in carrying out this measure to see that good drainage is provided throughout the whole kidney. In other words all dilated calyces must be opened up and drainage maintained in this state. Failure to accomplish this will add no benefit from the nephrostomy. Undoubtedly the best results from nephrostomy are obtained when the intervention is made early.

In certain cases it may be considered inadvisable to carry out nephrectomy at a later date or to delay removal of the kidney for an indefinite period. In these circumstances a permanent nephrostomy apparatus is fitted. This will enable the patient to lead a fairly normal sort of life with the exception of any form of violent exercise.

A successfully conducted and properly controlled nephrostomy can be responsible for restoring the patient to an excellent state of health and certainly will generally reduce the hazards which would otherwise exist when nephrectomy is undertaken.

It has been my practice in carrying out nephrostomy to arrange the opening into the kidney so that the tube enters the flank towards the front rather than the back. In this way the patient is able to exercise some personal supervision in the adjustment of the tube in the fistula (Fig. 433).

In the course of the convalescence following the wide opening up of a pyonephrosis drainage of the kidney by tube is maintained taking care that the tube enters well into the kidney. In these circumstances after reducing the size of the drainage tube to that of the nephrostomy tube the latter will fit easily into position. Strict supervision is necessary not only with regard to cleansing of the tube but also to see that the latter does not become shortened to the extent that the tube no longer enters the kidney. Should this occur much of the benefit of the nephrostomy will be lost and it may be necessary to dilate the fistula with gum elastic bougies before it is possible to reinsert the tube to the proper extent. For details of nephrostomy technique see p. 100.

Primary nephrectomy if it can be carried out as it often can is an eminently satisfactory procedure. In many cases this course is a perfectly proper one to follow especially if acute symptoms have subsided as a result of expectant treatment and once the patient is through the ordeal of the operation there will be the great advantage of a complete cure.

In carrying out this procedure the surgeon naturally tries to extirpate the kidney without rupturing it. He may not succeed in this and pus may escape into the wound or it may be wise to deliberately drain the kidney during the operation in order to reduce it in size. Although some infection of the wound will necessarily result from these measures serious consequences are not usual if generous drainage of the wound is provided before it is closed.

Subcapsular nephrectomy especially after nephrostomy always tends to simplify removal of a difficult kidney.

In certain cases after nephrectomy the ureter which is left behind remains the seat of inflammation and is responsible for continued pain. This ureteritis in due course may be expected to subside sometimes by causing complete

lead to pyelonephritis and death unless prompt steps are taken to deal with the distended bladder. The best treatment is the early establishment of permanent suprapubic drainage.

Although pyelonephritis can occur in spite of the most scrupulous observance of aseptic principles in relieving retention of urine, strict attention to these rules must never be relaxed.

**Acute pyelonephritis without retention**—The patient should certainly be confined to bed. The outstanding feature in the medication should be the administration of liberal quantities of fluid (about 5 pints in twenty-four hours).

Frequency of micturition is generally an accompaniment of these cases because cystitis usually precedes the renal infection. The bladder symptoms are often very distressing at one stage when there may be not only great frequency but dysuria and terminal hæmaturia as well.

The cystitis calls for local treatment not only to relieve the patient's distress but because of the beneficial effect that may reasonably be expected on the course of the renal infection. A hypodermic injection of  $\frac{1}{2}$  gr of omnopon or a suppository of morph hydrochlor, gr  $\frac{1}{4}$ , and ext belladonnæ alc, P B '98 gr  $\frac{1}{2}$  will give temporary relief from the discomfort. Washing the bladder out with 2 per cent boracic lotion, even on one occasion only, often has a dramatic effect on the course of the illness, benefiting both the vesical and the renal infection. The vesical lavage may with advantage be repeated daily for about a week. The principles already laid down with regard to diet and bowels should be followed. For medicinal treatment, see p 769.

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In carrying out this procedure the surgeon naturally tries to extirpate the kidney without rupturing it. He may not succeed in this and pus may escape into the wound or it may be wise to deliberately drain the kidney during the operation in order to reduce it in size. Although some infection of the wound will necessarily result from these measures serious consequences are not usual if generous drainage of the wound is provided before it is closed.

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obliteration of the lumen of the ureter but in exceptional cases a suppurating periureteritis is set up which leads to a discharging sinus. A urinary fistula is also seen from time to time the latter condition results from the ascent of urine from the bladder up the dilated ureter. As a rule by providing adequate drainage down to the open end of the discharging ureter the flow of urine may be expected to cease in due course.

The above complications of nephrectomy call attention to the necessity for removing as much as possible of a dilated or thickened ureter at the time of the nephrectomy whenever this is practicable.

**Chronic pyelonephritis without obvious obstruction**—The important line to follow is to seek out and treat any chronic focus of infection that might be keeping the urinary tract infection alive not forgetting to investigate the urinary tract itself so as to be able to remedy any abnormality there which might retard progress from the treatment. Of recent years a conception of the word focus has grown up which has tended to direct attention to such localities as the teeth the tonsils and the accessory air sinuses. Although such associations cannot be denied the foci already referred to as occurring in or adjacent to the lower urinary tract are much more important because they occur more commonly and treatment of the focus in question usually yields strikingly beneficial results on the urinary tract condition.

It is a complete misdirection of energy in such cases to concentrate attention upon attaining a sterilization of the urine while the primary source of the infection is left to reproduce urinary tract infection at a later date.

For medicinal treatment of the infection see p. 769.

The amount of success achieved in relation to the kidney by treating the primary focus of infection will depend largely on what chronic changes have already taken place in the kidney itself. Degeneration of the parenchyma particularly where this gives rise to the changes recognized in pyelograms as obliteration abbreviation or clubbing of the calyces must be considered as permanent. The same applies to dilatations without obstruction involving the pelvis or ureter. The presence of any of the above abnormalities in any important degree would render it unlikely that an existing chronic renal infection would ever be permanently eradicated.

**Urinary tract infection in children**—Acute infections are commonly referred to as pyelitis but in many cases the evidence that the kidneys are involved is lacking the predominating feature being that of cystitis but nevertheless pyelonephritis is likely to occur. Confinement to bed and the taking of copious fluids are the important principles of treatment to observe. Where fluids taken by the mouth is a difficulty the intramuscular or the subcutaneous method is the next best alternative. Most cases make a straight forward recovery even by these simple means. Intravenous administration should be employed only when the intake can be carefully checked against urinary output.

Medicinally success is claimed for several different lines of treatment—large doses of alkalis acidification of the urine and formaldehyde containing drugs ketogenic diet sulphonamide group of drugs (see p. 767).

If the case tends to continue in a subacute or a chronic form or if acute attacks tend to recur then a careful investigation must be carried out to ascertain if there is a focus of infection or a urinary tract abnormality which is primarily responsible for the infected state.

The whole extent of the urinary tract must be carefully searched and if some condition is found which predisposes to infection and which cannot be remedied then there is no prospect of keeping the urinary tract permanently free from infection.

Dilatations with or without obstructions are both found. The latter unfortunately are only amenable to remedy when localized to one side of the upper urinary tract. Dilatation from obstruction does not present the same difficulty in treatment. It is sometimes necessary in this connection to do a nephrectomy because of a stenosis of the ureter.

Apart from the more obvious conditions in the urinary tract there are certain minor ones which might easily escape attention and which are important as predisposing causes of urinary tract infection and because they are amenable to treatment.

In the male there are the following: Phimosis, balanitis, adherent foreskin with retained smegma, meatitis in the circumcised, atresia of the external urinary meatus which is more common in the circumcised. All these conditions lead to a mild infection of the urethra and ultimately of the posterior portion.

In the female there is the same type of urethritis, often as a part of a simple chronic vulvitis. More rarely a chronic cervicitis is present.

A mild chronic form of urethritis, the origin of which is unknown and which is only identifiable by urethroscopy, occurs in both sexes.

Sometimes there is generalized narrowing of the whole urethra in a not very marked degree and which is easily overlooked.

The treatment of phimosis, balanitis, adherent foreskin and meatitis does not require elaborating. Meatotomy for atresia of the external urinary meatus however requires special care and supervision. The meatus should be enlarged with a pair of pointed scissors, taking care to cut just to one side of the frenum down to the level of the coronal sulcus. Bleeding is controlled by pressing the cut edges together for two minutes. The whole urethra is next gently dilated with the proper metal sounds for children. Then some  $\frac{1}{2}$  in ribbon gauze soaked in liquid paraffin is packed into the navicular fossa. This is removed when the patient first passes water. Each day for the next five days the cut edges are gently separated. The cases of chronic urethritis and urethral narrowing should be treated by dilatation (see p. 279).

**Urinary tract infection during pregnancy and the puerperium.**—The term *pyelitis of pregnancy* is used loosely in reference to urinary tract infection discovered during pregnancy or the puerperium. The treatment adopted will naturally vary according to the nature of the symptoms which may occur suddenly or insidiously and be mild or severe. If there is any pyrexia, vomiting or other toxic symptom, rest in bed must be insisted upon.

In the acute stage the treatment will not vary from that of ordinary acute pyelitis. That is to say liberal fluids, light diet, urinary antiseptics (see p. 714) and careful supervision of the bowels. In the chronic stage the patient may complain of no symptoms which call attention to the urinary tract and the infection may owe its discovery to the routine examination of the urine. As soon as is practicable a thorough investigation must be made. This will include intravenous urograms, cystoscopy and possibly urethroscopy.

Occasionally an important condition such as a urinary calculus or hydro-nephrosis is discovered and the question will have to be decided whether an operation should be done at once or delayed until after the confinement. If such a discovery is not made until late in the pregnancy and there are no severe symptoms related to the urinary tract, surgical treatment should be postponed. If on the other hand the urinary tract abnormality is detected at an early stage of the pregnancy and there have already been alarming symptoms, operative rectification of the condition should be carried out as soon as possible. The prospects of being able to do this without disturbing



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Occasionally an important condition such as a urinary calculus or hydro-nephrosis is discovered and the question will have to be decided whether an operation should be done at once or delayed until after the confinement. If such a discovery is not made until late in the pregnancy and there are no severe symptoms related to the urinary tract, surgical treatment should be postponed. If on the other hand the urinary tract abnormality is detected at an early stage of the pregnancy and there have already been alarming symptoms, operative rectification of the condition should be carried out as soon as possible. The prospects of being able to do this without disturbing

the pregnancy will vary according to the stage of the pregnancy and the severity of the operation

In an uncomplicated case which has passed from the acute into the subacute stage daily bladder lavage (see p 697) should be added to the routine measures already mentioned and if this does not suffice drainage of the one kidney or both kidneys by leaving ureteric catheters in position for several hours may produce a dramatic improvement But ureteric catheterization should be undertaken only with a full sense of responsibility regarding the danger of interrupting the pregnancy Woodruff (1943) believes that the indwelling ureteric catheter constitutes an important cause for the beginning of uterine contractions It is therefore important that other means should be tried before resorting to this measure and that when it is employed the catheter should be left in position no longer than is absolutely necessary

As already pointed out pregnancy cases of urinary tract infection are simply ordinary cases of urinary tract infection which have been aggravated by the pregnancy Therefore at a convenient time after the puerperium steps should be taken to deal with any predisposing cause that has been discovered For example a cervical erosion should be cleared up and any necessary treatment for the urethra or bladder neck carried out

### INFECTION OF THE URETERS

Ureteritis is nearly always part of an inflammation which involves the kidney and often the bladder as well and although it is exceptional to find an inflamed ureter without the kidney being involved yet in certain cases the parenchyma is the seat of an inflammatory process while the pelvis and ureter are not

If there is any narrowing of the ureter as a result of the inflammation an aggravation of the latter condition must be expected in the kidney

Cases where only a part of the ureter is the seat of inflammation have been recorded (Fig 368)

**Ætiology**—The organism is the same as that which affects the kidney The responsible organisms in their order of decreasing frequency are as follows coliform bacilli enterococci staphylococci streptococci proteus bacilli pneumococci gonococci pyocyaneus bacilli

Infection can occur by a number of routes —

- (a) The ascending route is the most frequent one following urethritis urethral stricture cystitis prostatic disease calculus foreign body and new growth of the lower urinary tract and disorders of the reproductive organs in the female
- (b) The descending route the ureter being infected secondarily to any inflammatory condition in the kidney
- (c) Direct spread from a focus of inflammation adjacent to the ureter such as salpingitis inflammation of the broad ligament appendicitis proctitis and vesiculitis
- (d) Direct spread from accidental wounds or operations on the ureters
- (e) Through the blood stream This route is admittedly rare but seems to occur as a localized ureteritis in the presence of a ureteric calculus

Infection of the ureter is encouraged by a pre existing state of the ureter for example dilatation which may result from an obstructive condition in the lower urinary tract or may exist without any apparent cause (Fig 369)

**Pathological anatomy**—**ACUTE URETERITIS**—In this state the ureter is thickened oedematous and its lumen is enlarged The inflammation may be



FIG 368

Localized inflammatory dilatation of left ureter. Intravenous urogram in a woman aged 40 who had suffered from attacks of cystitis on and off for seven years.



FIG 369

Lateral dilatation of ureters in a case of generalized chronic urinary tract infection.

localized to the inner coats but generally the whole thickness of the wall is involved. The mucosa is seen to be injected and often petechial hæmorrhages are present. Microscopically an infiltration with leucocytes extends through the inflamed zone. In places small areas of necrosis indicating abscess formation and interstitial hæmorrhages may be noted.

The inflammation generally involves the ureter in its whole length although the condition may be more marked in some areas than in others. Occasionally the inflammation is strictly localized to a segment of the ureter generally towards the lower end (Legueu 1921).

Periureteritis generally accompanies the inflammation of the ureter and may proceed no further than œdema or exceptionally it may go on to abscess formation which commonly presents in the iliac fossa. The latter course of events is generally due to the presence of stone in the ureter.

**CHRONIC URETERITIS**—This condition is most commonly demonstrated in association with obstructive conditions of the lower urinary tract for in these states there is a pre-existing dilatation of the ureters which encourages infection. In these circumstances the condition is bilateral and the ureters become thickened, elongated and tortuous. These changes are accompanied by a deposit round the ureter of fibrous tissue which fixes the tortuosities firmly by adhesions and may result in narrowing of the lumen in places. As indicated in Chapter I marked periureteric changes may be due to infection which has ascended entirely outside of the ureter.

The ureteric orifices may be normal in appearance but even so they no longer function normally because of the rigidity of their walls. This rigidity is due to changes in the bladder wall resulting from distension and infection. In other cases they are fixed in a gaping condition. Sometimes they are retracted as well as gaping. Another variety of chronic ureteritis is ureteritis without dilatation characterized by thickening of the walls without an increase in calibre or length of the canal.

Histological examination of the walls of these chronically inflamed ureters shows in certain places a loss of epithelium replaced by fibrous tissue. The mucosa is thickened and infiltrated with leucocytes. The muscular layer is equally thickened because of sclerosis between the muscle bundles.

*Pseudo-membranous ureteritis* is a rare form of the inflammation in which the wall is covered in certain places by a greyish false membrane resulting from a necrosis of the superficial layers of the mucosa.

Another unusual form is *cystic ureteritis* in which the mucous surface is dotted with numerous small cysts produced by the obliteration of gland-like structures which are inflammatory in origin.

**PROURETER**—This can occur when a dilated ureter which may contain a stone has been left behind when nephrectomy is performed.

**Symptoms and signs**—Pain is the outstanding feature and occurs from two different causes. The pain of a diseased ureter, the pain of a diseased kidney which is referred along the ureter. Colic may occur in either the acute or the chronic form of inflammation.

Both the pain and tenderness caused by the ureteritis occur along the course of the channel. The latter sign is particularly to be noted on rectal or vaginal palpation or in the para-umbilical region. In exceptional cases palpation not only elicits tenderness but allows the thickened channel to be felt. Frequently it is the symptoms of renal disease which dominate the picture.

**Diagnosis**—As the ureter is commonly inflamed along with the kidney in cases of renal infection it is not uncommon in acute cases especially when ascending in origin to find tenderness along the line of the ureter.

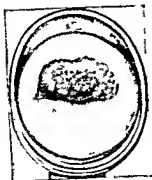


FIG 370

Cervical erosion in same patient as Figs 371 372 and 373

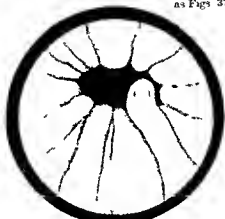


FIG 371

Urethroscopic view showing a large single urethral polypus projecting towards the internal urinary meatus

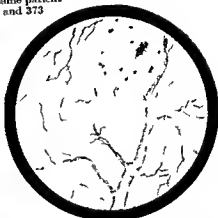


FIG 372

Cystoscopic view showing chronic inflammatory changes at the left ureteric orifice, this is constricted and surrounded by petechiae



FIG 373

Cystoscopic view showing marked chronic inflammatory changes involving the trigone, and bladder changes behind this. The patient was a woman aged 64 whose left renal pelvis contained a stone and whose right renal pelvis was mildly dilated. There was also a cervical erosion (See Fig 370)

In vaginal examination in the female and on rectal examination in either sex this sign can often be elicited at the lower end of the ureter. The knee elbow or flexed lateral position may enable the finger to reach the tender point in a difficult male case. A desire to micturate as a result of pressure with the finger on this region is a further sign. A thickened ureter felt in this way will raise the question of tuberculousis.

Mild dilatation or tortuosity of the ureter as manifested on excretion urograms when not explicable on the basis of an obstructive condition and except in pregnancy cases should generally be regarded as indicating an inflammatory state. This is often so in cases of mild chronic infection of ascending origin and in which infection is not suspected.

**Prognosis**—The outlook for the ureter depends upon the extent of the changes that have already occurred and upon whether or not there are chronic lesions of the bladder or kidney. In the presence of any of the latter a gradual deterioration in the condition of the ureter must be expected. With regard to the former if there is already tortuosity adhesions and dilatation to any extent the prospect of improvement would be small without surgical intervention.

**Treatment**—As the inflammation has generally spread to the ureter from an adjacent organ it is the latter which will require to be treated.

For example either the kidney or the bladder or both these organs may call for attention. Drainage of an inflamed kidney or bladder can appreciably improve the condition of the ureter.

There are certain cases where an inflammatory process has left behind a constriction of the ureter which will encourage inflammation to persist in the kidney as well as in the ureter. In some cases the remedy for this will often require surgical interference to relieve the obstruction. In others it is advisable to keep the narrowing under control by intermittent dilatation with ureteric instrumentation.

There are some unilateral cases however where as a result of the condition of the ureter the changes in the kidney indicate that there is no other course to follow than to perform nephrectomy.

Pououretcr requires ureterectomy.

Where a periureteral abscess has resulted this will require incision and thorough drainage. Later it may be necessary to undertake further surgical measures to deal with the underlying cause of the suppuration.

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## CHAPTER LXVIII

### PERINEPHRITIS

#### NON-SUPPURATIVE NEPHRITIS

**P**ERINEPHRITIS is invariably associated with acute or chronic inflammatory diseases of the kidney. It is most commonly seen with renal stones, tuberculosis, infected hydronephrosis or pyonephrosis and chronic pyelonephritis.

**Pathology**—The inflammation leads to a diffuse or localized fibrous tissue formation between the renal and perirenal capsule. The perinephric fat may be unaffected or increased especially in the region of the renal sinus and along the vessels in the renal pedicle. With suppurative lesions in the kidney the fibrous tissue may be greatly increased and the fat may be oedematous or may disappear altogether, the fibrosis extending into the kidney tissue which shrinks, indeed, at operation it may be difficult to find the kidney. This is known as the fibrous or sclerotic variety of perinephritis as distinguished from the fibro lipomatous type in which the chief change is an increase in the amount of perinephric fat, which becomes lobulated and densely adherent to the renal capsule, and so hard that on exploration it gives the impression of a growth.

When the infection of the kidney lies chiefly in the renal pelvis these changes are most likely to affect the renal sinus (perisinusitis), the renal vessels being constricted and lying in the midst of thick, hard fat. If the renal lesions are at the poles, change is liable to be localized to these areas, spreading over the kidney as the disease extends. With tuberculosis of the kidney the fat may be found to be infiltrated with tuberculous inflammatory material.

The perinephric thickening may be very adherent to the surrounding tissues—diaphragm, colon, peritoneum, etc.

**Symptoms and signs**—Perinephritis is most often unrecognized by virtue of any symptoms it produces, and is first discovered at an operation to deal with an underlying lesion in the kidney. Sometimes, although symptoms may suggest renal disease, no lesion is found other than a mild haecilluria, which may at the moment of investigation even be absent. Some observers regard the disease as a clinical entity. Weyman (1940), for example, regards 80 per cent of cases with these symptoms—and sometimes including haematuria, unassociated with obvious renal lesions—as having a unilateral origin, mostly on the right side, secondary to infection from the renal pelvis through the vessels of the cortex or via the lymphatics from the bowel.

Renal pain may be a prominent symptom, either of the nature of colic or of a dull aching character, present day and night. In the absence of other evidence, perinephritis may be suspected.

The urine may be normal or intermittently contain pus and bacteria.

The kidney, if felt, may have lost its mobility. In the most advanced cases an indefinite swelling may be discovered.

Intravenous pyelography may prove loss of renal function. Retrograde pyelography may demonstrate a shrunken renal pelvis capable of holding only 2 to 3 c.c., due to a mass of dense fibrous tissue surrounding it, or to chronic infection, the pelvis may be distorted if bands of adhesions stretch across it. The ureter may show kinking and displacement.



**Treatment**—Treatment of perinephritis depends on the measures required to deal with the disease in the underlying kidney. In the milder cases after dealing with the primary lesion removal of infiltrated perinephric fat especially after nephrectomy for tuberculosis should be carried out. In the most severe cases it may be impossible to do anything with the thickened fibro fatty tissue except that it may have to be incised so that the kidney may be removed by the subcapsular method. If no obvious lesion can be found in the kidney and pain is a prominent symptom decapsulation of the kidney is the only measure of treatment which suggests itself with removal of as much of the fibro fatty tissue as possible especially from the region of the pedicle. This must be carried out with the greatest care. Bands causing kinking of the ureter or renal pelvis should be excised.

### SUPPURATIVE PERINEPHRITIS

A perinephric abscess originates either from a pre existing lesion of the kidney or from an infection reaching the kidney area via the blood stream or lymphatics. It lies in the first instance within Gerota's capsule and tends to remain localized to that situation. It is one of a number of abscess formations classified as subphrenic the majority of which lie outside the capsule. It will be seen from the following percentages in 3 608 cases of subphrenic abscess compiled by Ochsner and de Bakey (1938) that abscesses connected with the kidney are relatively few (7.6 per cent). The majority are connected with the bowel and neighbouring structures —

Appendix	30.7 per cent
Stomach and duodenum	28.7
Liver and bile passages	12.8
Thoracic lesions	2.4
Spleen	3.7
Pancreas	1.2
Intestine	1.8
Female genitalia	1.4
Metastatic or primary	3.2
Kidney	2.0
Traumatic	2.4
Tubercle	0.9
Unknown	7.4

**Ætiology**—The origin of perinephric abscesses may be set out as follows —

#### 1 RENAL CAUSES

- (a) Rupture of or lymphatic extension from a pyonephrosis associated with calculus formation tuberculosis renal carbuncle or other suppurative lesions of the kidney
- (b) Trauma leading to rupture of the kidney

#### 2 EXTRA-RENAL CAUSES

- (a) Metastatic from a distant lesion
  - (i) By direct infection of the perinephric tissues
  - (ii) By pyogenic metastasis in the kidney with secondary involvement of the perinephric tissues
  - (iii) By lymphatic infection along the ureter from pelvic suppuration
- (b) Direct infection from subphrenic abscesses or pelvic abscesses tracking upwards along the ureter

The metastatic variety is the commonest form of perinephric abscess. The infection is brought to the renal area by the blood or lymphatic stream from a distant infected lesion commonly in the skin, the upper respiratory passages, the prostate etc. The primary focus may be still present or have healed months before the perinephric abscess develops. Although there are differences of opinion it is fairly clear that the perinephric fat becomes secondarily involved from the renal tissues. Cortical abscesses or scars of such can be found in the kidney at operations or in the post mortem room in nearly all cases. This view is now commonly held and has been confirmed by many observers. Cases of bilateral abscess formation have been noted.

The remainder of the perinephric abscesses are secondary to pre-existing lesions e.g. pyonephrosis, stone, tuberculosis, trauma etc.

It is reported that in children perinephric abscesses do occur apart from renal infection and a few writers state that such may happen even in adults as primary or bilateral lesions.

**Pathology**—Perinephric abscesses are usually unilateral and are commonly on the right side; they may be bilateral. They may bear no relation to the kidney but most commonly are found behind and nearer the upper than the lower pole, thus the kidney is pushed downwards and forwards, rarely do they spread to the front of the organ. They may remain localized first inside the renal (urogenital) and later inside the perinephric fascia but have a tendency to track downwards along the ureter inside the former sheath (Fig. 1) and the psoas muscle to reach the pelvis and groin. In late stages the abscess may point through the abdominal wall either in the post renal angle or in Petit's triangle. The wall of the abscess which is often densely thick and fibrous becomes firmly adherent to the surrounding tissues, especially the diaphragm and muscles of the posterior abdominal wall. The abscess may rupture into the surrounding tissues, the peritoneal cavity or the bowel. By lymphatic spread it may infect the pleura and even cause an empyema.

**Symptoms, signs and diagnosis**—Perinephric abscesses are most commonly found in male adults between the ages of 25 and 45; they also occur in children. Greenwald and Kresky (1941) record eleven cases in children under 1 year of age.

When the abscess is a complication of some renal disease e.g. renal calculus, tuberculosis etc. with pus formation, suspicion that an abscess is forming is raised by an exacerbation of the previous symptoms and signs. The diagnosis is difficult, however, with cases of metastatic abscesses unassociated with symptoms of a renal lesion. The same may be said for those having an extra renal origin.

The onset is generally insidious. In more acute cases a rigor or series of rigors usually preceded by a period of general ill health and fatigue is the symptom followed by remittent fever oscillating between 100 and 104 to 105 degrees Fahrenheit without any localizing symptoms.

A variety of diseases are suspected among the commonest being typhoid fever, influenza, pneumonia, phthisis, infective endocarditis, pyelitis etc. The possibility of a perinephric abscess should be included in this list especially if a history of a recent or remote skin lesion can be obtained.

As a first step a blood examination including blood cultures, agglutination tests, urine examinations should be made. A polymorphonuclear leucocytosis of 12 000 to 25 000 per c.c. will exclude the first two on this list. Bacteria and pus in the urine and the nature of the micro-organism will be most useful indicators.

A period as long as two to five weeks during which the patient may become

very ill indeed may intervene before localizing symptoms develop. In the early stages pain may be absent or quite insignificant but eventually general abdominal pain backache resembling lumbago or fibrositis or a typical deep seated renal pain of either the dull ache or renal colic variety appears. The pain is increased if when standing erect attempts are made to bend towards the opposite side an effort which may be impossible owing to the rigidity of the erector spinae muscle on the affected side. Attempts to roll over in bed have the same effect. Pain may be referred to the hip joint or thigh and be associated with a limp owing to spasm of the psoas muscle.

A troublesome and persistent cough aggravating the pain especially if accompanied by trivial abnormal physical signs often leads to an erroneous diagnosis of a thoracic lesion.

Physical signs may be completely absent. Tenderness and rigidity of the lumbar and upper abdominal muscles may prevent an adequate examination of the loins without an anaesthetic. The thigh on the affected side may be drawn up and rotated outwards and a kyphosis produced on attempting to extend the leg suggesting in a child the presence of spinal or hip joint disease. The latter will be excluded by demonstrating free movements in the hip joint in the flexed position.

With the patient in the sitting position on deep inspiration diminished expansion of the lower thorax may be observed. Air entry may be diminished and signs of oedema of the base of the lung may be present. Sometimes a small pleural effusion is found which on withdrawal may show the presence of polymorphonuclear leucocytes.

As the abscess enlarges tenderness on palpation or percussion in the costovertebral angle or on pressure on the last rib becomes an evident sign.

On deep palpation in the hypochondrium an indefinite swelling may be felt well up under the rib margin. A diagnosis of a pyonephrosis rather than a perinephric abscess should be made if the margin of the lower pole of the kidney can be readily distinguished.

Eventually a palpable tumour which does not move on respiration bulges into the loin. Such a swelling is commonly the first evidence of the presence of a perinephric abscess. Atcheson (1941) in his series states that a mass on the loin was discovered in 60 out of 117 cases on the day of their admission to hospital. Later the skin becomes red and oedematous.

A careful examination of the lower abdomen is required to exclude the possibility of the abscess arising from the appendix or a pelvic lesion tracking upwards.

The urine may or may not show any abnormality. The absence of pus does not necessarily mean that the kidney is not involved. Pus and bacteria commonly the *staphylococcus pyogenes aureus* are usually found after the first week or ten days. A pyuria without bacteria suggests the presence of a tuberculous lesion in the kidney. Other bacteria are streptococci and *B. coli communis*. Confirmation of these findings by ureteric catheterization is useful and in doubtful cases will indicate which kidney is involved. The pus is seldom large in amount unless a pyonephrosis is present.

Radiography serves two purposes first in helping to arrive at an early diagnosis and secondly in excluding such external origins as caries of the spine hip disease renal calculi or possibly tuberculosis of the kidney.

The following positive evidence of a perinephric abscess may be found and one or more of the findings may be observed. (1) Abnormal shadow in the renal fossa. (2) fixation of the kidney on respiratory or positional movement best demonstrated in association with pyelography which according to



FIG 374

A plain radiogram showing on the left side obliteration of outer margin of psoas muscle and lowering of tip of the 12th rib (Mr Wansbury White's case)



FIG 375

Intravenous pyelogram showing two patches of opaque medium well below the lowest group of calyces of the left kidney indicating abscess cavities (Mr Wansbury White's case)

Mathe (1937) is an early sign occurring in all cases (3) blurring of the margins of the psoas muscle (Fig 374) (4) displacement of the kidney downwards and forwards demonstrable in lateral pictures especially pyelograms (5) lateral curvature of the spine with concavity towards the affected side (Fig 374) (6) fixation of the diaphragm on respiration (7) demonstration of a small pleural effusion (8) displacement of the hepatic or splenic flexures (9) a pyelogram in the presence of a renal carbuncle will show splaying or deficiency of the calyces or the absence of a pelvic shadow if obtained by the intravenous method (10) a pyelogram may show the opaque medium to be



FIG 376

An instrumental pyelogram which shows a large abscess cavity  $\circ$  is de the kidneys (Mr W Nabury White's case)

distributed in an irregular manner especially when this is seen outside the renal outline (Figs 375 and 376)

It may be very difficult and even impossible to discover a small abscess tucked up between the liver diaphragm kidney and spine without exploration

**Treatment**—There is only one method of treatment namely to evacuate the abscess Primary staphylococcal abscesses should not be opened in too great a hurry unless there is clear evidence that pus is present when the sooner they are opened the better

The operation should be carried out by a wide incision through the muscles of the loin Other routes show a much higher mortality transperitoneal route 48.2 per cent transpleural route 50 per cent transmuscular route

10.8 per cent. Although the abscesses are as a rule unilocular care should be taken that no pockets or side tracks are left unopened or undrained. The surface of the kidney should be carefully examined for a rupture, a discharging carbuncle, a scar on its surface, a pyonephrosis, etc. It is seldom advisable to remove the kidney at this stage even if a primary cause is present. A similar lesion may be there or appear at a later date in the opposite kidney although this is uncommon. An abscess in the kidney may drain and leak as soon as the perinephric abscess is evacuated. Failure to do this invariably leads to the formation of a sinus which indicates the need for a secondary nephrectomy. A pyonephrosis should be drained. Further interference is to be avoided until later.

Abscesses due to local extrarenal causes should be similarly dealt with. The foul smelling pus of an appendix abscess—the commonest cause—is usually sufficient to indicate its origin but whatever the cause the original lesion should be dealt with at a later date. A tuberculous abscess of the spine requires the conservative technique to which these lesions are always submitted.

### PERINEPHRIC SINUS

This occurs between the skin in the lumbar region and the perinephric tissues. It is commonly connected with the kidney resulting from an opening of that organ as by nephrostomy or upon the incision of a perinephric abscess and may persist after the ineffective removal of an obstruction of the ureter by calculus.

Probably the commonest form of perinephric sinus is the leakage of a tuberculous spinal abscess which has tracked backwards along the sides of the vertebrae through the lumbar muscles. These sinuses may be close to the mid line or pass to the surface via Petit's triangle.

Any abdominal abscess which tracks into the loin may point and rupture in this region. The commonest is retrocecal appendix abscess. A duodenal fistula resulting from injury during the removal of a kidney is not unknown but must be rare.

The history of the origin of the fistula should indicate its cause but if this fails the passage of radio opaque material along the sinus will do so. The first of these requires removal of the kidney, the second the conservative measures usually employed in the treatment of spinal disease, the third the removal of the appendix, etc. and the last the closure of a duodenal opening accompanied by a gastro enterostomy.

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(Reviewed by the Editor.)

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## CHAPTER LXIX

### URINARY FEVER AND URÆMIA

**T**HIS term is used to cover all the various phenomena which occur as a result of the entry of bacteria or their toxins into the organism from a focus in the urinary system

Several grades of this infective process can be recognized —

- 1 The indications are that the inflammation is purely local in one part of the urinary tract, *e.g.* the urethra and its adnexæ, the bladder, the kidneys
- 2 There is a state of pyæmia as a result of the spread of the infection by way of the blood stream from the urinary tract. Bones joints cellular tissue and viscera may be involved
- 3 There is a blood invasion producing a septicæmia
- 4 A chronic, and often insidious, urinary tract infection gives rise to chronic inflammation of the joints, fibrous tissue planes, nerves, viscera, the cellular tissue of the true pelvis and the abdominal wall

#### SYMPTOMS AND SIGNS

Three degrees of the infection are recognized according to the length of time that the symptoms persist —

- 1 Acute transitory    2 Acute protracted,    3 Chronic

**Acute transitory**—There is an attack of fever following a period of malaise. The patient feels cold there is a *rigor*, the countenance becomes drawn and anxious the pulse and respirations accelerate, and if the condition deteriorates the rigors may persist for several hours and the patient may lapse into unconsciousness, to be followed by delirium and death. The shivering attack is followed by an appearance and sensation of warmth, the temperature goes up and the tongue and skin become dry, after a variable period, if recovery takes place, profuse sweating occurs, and the whole attack may have lasted not more than two or three days. Exceptionally a relapse occurs leading to death.

As the rigors cease the *temperature* rises briskly often to fall back dramatically within a few hours.

**Acute protracted**—In this type there is a repetition of attacks of urinary fever or a single attack is drawn out to a variable length.

There is an *initial rigor*, which tends to be prolonged and which is not followed as a rule by such clearly defined phases of pyrexia and sweating as is seen so commonly in a transitory acute attack. These symptoms indeed may be quite absent. The temperature instead of falling completely after the rigor has finished, makes a partial drop and then tends to move irregularly, a fresh rigor being marked by a fresh rise.

In this way the fever may run an intermittent course over a considerable period, rises occur without any apparent cause. The rigors may be quite

absent or oft repeated up to a period of a week during which time they show a gradually diminishing intensity in a case that is recovering

All the various systems of the body in due course show their reactions to the infection

**THE DIGESTIVE APPARATUS** shows early changes The tongue at first is red at the tip and sides and coated in the middle Later it becomes dry and hard The lips become dry the saliva is scanty and thick deposits of mucus project from the buccal mucosa where even thrush may develop swallowing is difficult The appetite goes digestion becomes poor and vomiting may occur

There is an interference with the activities of the intestines stubborn constipation is sometimes followed by persisting diarrhœa while prominence of the abdominal wall from accumulated intestinal gas is a fairly constant feature

**THE RESPIRATORY APPARATUS** is invariably affected some degree of congestion of the lungs is the rule

**THE HEART'S ACTION** becomes affected this is apparent in an increase in the rate a loss of strength and irregularity

**THE MENTAL FACULTIES** are impaired there are troubled dreams and sometimes delirium

**THE KIDNEYS** show evidence of involvement by the following signs —

Diminished urinary output tenderness enlargement The last sign is not necessarily present

**PROGNOSIS**—This is a more serious form than the acute transitory, as it more commonly leads to a fatal issue Pyrexia becomes more persistent, the pulse remains accelerated and becomes weaker urinary excretion diminishes and the patient passes into coma as a terminal phase before death supervenes In the final stages the temperature sometimes falls while the pulse continues to deteriorate and the urinary output progressively diminishes On the other hand if the fall in the temperature indicates a change for the better there will be a corresponding improvement in the pulse and quantity of urine excreted together with the evidence that recovery is taking place

**Chronic form (uræmia)**—This may commence as such or succeed the preceding type Pyrexia is commonly an inconspicuous feature, it may be quite absent, when present fairly regular mild oscillations are the rule, often the temperature remains subnormal The widespread manifestations seen in the acute protracted form are also apparent to a lesser degree, and there develops a chronic state of cachexia—uræmia—which is characteristic of certain chronic urinary cases, many of these progress to a fatal issue The appearance of the patient indicates a loss of flesh and the skin becomes wrinkled, pale or yellowish

The urine in the chronic form is often pale and plentiful sometimes it is turbid

All symptoms and signs slowly disappear if recovery occurs but relapses are common

Less striking evidence of the chronic state is sometimes present and the symptoms may easily escape recognition as those dependent on changes in the urinary tract Diminution of mental alertness loss of energy, loss of appetite constipation with flatulence some frequency of micturition from polyuria, such symptoms commonly depend upon a certain degree of chronic urinary tract disease It should be clearly understood that the uræmic state is not dependent on an elevation of the blood urea, it is often present when the blood urea is low and absent when the blood urea is high



### COMPLICATIONS

During the course of the acute protracted or chronic forms certain infective complications may occur. These present themselves as either septicæmic or pyæmic manifestations and the following conditions are more commonly seen: skin eruptions, isolated indurations in cellular tissue planes, suppuration in muscles, suppuration in viscera, arthritis, parotitis.

Although a case may proceed to death and autopsy may fail to reveal renal involvement, yet a complicating infective process in one or other kidney is usual in such cases where suppuration is present; this takes the form of miliary abscesses throughout the parenchyma. An increase in blood urea is the rule when the renal inflammation is prolonged and makes the prognosis bad.

### ÆTIOLOGY

Attacks of urinary infection are spontaneous or provoked.

The spontaneous variety is commonly seen in cases of chronic bladder neck obstruction of different kinds which are complicated by residual urine in the bladder, but it also occurs independently of these predisposing causes.

The provoked variety (catheter fever)—This is the more common and arises from instrumentation of the urinary tract even when this is carried out with due skill and care, but an unskilled technique in the passage of instruments per urethram or the mere bad choice of instruments is a more common cause. Trauma from lithotripsy is likely to produce it, with internal urethrotomy the rise of temperature may not occur until after the removal of the indwelling catheter. It is sometimes seen after the passage of ureteric catheters. Vesical irrigations or instillations may also be the precipitating cause. During the convalescence of prostatectomy attacks of urinary infection are likely to occur especially after urethral instrumentation.

### PATHOLOGY

The course of events when urinary infection occurs indicates that —

- 1 The lower urinary tract rather than the upper is commonly the original seat of the infection.
- 2 The kidneys tend to be involved early in the infection.
- 3 There is a danger of the infection being carried about the body in the blood stream.

The following considerations are of special interest —

- 1 In the earliest cases there are no signs that the infection has spread beyond the lower urinary tract.
- 2 In those cases which arise spontaneously evidence of pre-existing disease of the lower urinary tract or the genitals can usually be obtained; a lighting up of a latent focus of infection is the common cause of the attack.
- 3 An attack provoked by instrumentation may obviously be due to the same cause; such a course of events may be assumed where the urine is previously sterile and due skill and care are exercised and no difficulty arises with the instrumentation.

- 4 The presence of pre-existing infection in the urine especially when there is residual urine in the bladder is a frequent antecedent of urinary fever both with and without instrumentation. It is the common belief that in these circumstances following instrumentation fresh organisms gain access to the tissues, through a traumatized mucous surface. It may be remembered however that in such cases organisms are already in the tissues—generally the prostate—and can be easily stirred into activity by trauma. In the circumstances it is rather an academic point as to which process occurs.
- 5 The danger of introducing fresh organisms on the instrument cannot be denied and demands all the proper aseptic measures to prevent this, on the other hand catheter fever can follow in spite of the exercise of proper skill and the most rigid precautions including a preliminary urethral irrigation. It may therefore, be reasonably assumed that an attack of infection following instrumentation can occur without introducing fresh organisms on the instrument.
- 6 Pre-existing kidney disease is often a predisposing factor in a case which becomes complicated by renal infection. This predisposition may be assumed when residual urine—particularly when this is infected—is present in the bladder, but the absence of residual urine is sometimes noted.
- 7 The reaction to the entry of organisms into the blood stream may be severe, but only transitory provided that the invasion is not considerable, the virulence of the organisms is not high, the kidneys have not been previously badly damaged.

According to the extent to which the above conditions prevail so the features of the case indicate the different clinical types namely acute transitory, acute protracted, abscess formation, chronic.

Pus-formation in the kidneys may end in resolution—the pus being discharged into the renal passages—or may lead to grave toxæmia and death.

Pus formation in other situations may determine a similar course of events namely resolution, escape of pus, or a fatal issue. Surgical intervention to evacuate pus may result in cure.

The uræmic state inevitably comes with the terminal phases of all urinary infections which end fatally, and is most commonly seen in the chronic form, the symptoms increase in proportion to the destructive processes which are going on in the kidneys.

#### DIAGNOSIS

An acute attack—Malaria, renal and biliary colic, septicæmia, are the principal conditions which will need to be excluded. The recent history, and findings in connection with an examination of the urinary tract, will always suffice to locate the real seat of the infection.

A protracted acute attack—Once again malaria must be considered and typhoid fever excluded.

Suppuration in the urinary apparatus or the adnexæ is sometimes overlooked as the cause of continued symptoms of infection. The prostate, the cellular tissue of the periprostatic and the perivesical regions are sometimes the seat of this form of inflammation, while the kidneys are the commonest seat of such a process, from which perinephric suppuration may result.

Chronic urinary infection—The real origin of the symptoms may escape notice because the symptoms are often more strikingly related to parts outside the urinary tract, as, for example, to the digestive system.

Persisting evidence that the kidneys remain infected gives a grave prognosis to this type of case. Tenderness on pressure in the renal regions is the certain and simple sign of renal involvement.

**Abacterial urine in the presence of urinary tract infection**—It is important to be aware of the fact that an infection may exist in the urinary tract although bacteriological evidence has been sought for in the urine and not found.

**Abacterial pyuria**—The condition is most commonly met with as a urethritis. When the urethral discharge is purulent and abundant the urethral origin of the condition is not likely to be overlooked. In some cases however, the discharge is clear and so scanty that it might easily escape detection unless the external urinary meatus is examined carefully after several hours of retention of urine. In these circumstances, if the inflammation does not involve the bladder the two-glass test will make it quite clear that the urethra—generally the posterior—is the seat of infection, for this simple procedure will show in the first glass, turbidity or debris or both, and in the second a non-turbid urine without debris. When the bladder is obviously involved in the inflammation as well, there will be pus in both glasses, but urethral inflammation will still be indicated when debris is present in the first, and barely so or absent from, the second.

When the pus in the urine is merely microscopic there is an obvious need for urethroscopy. One may go a stage further and emphasize the fact that there are many cases with disturbances of micturition where neither bacteria nor pus cells can be found in the urine in spite of a painstaking search, yet urethroscopy reveals a chronic inflammatory process, generally granulomatous in nature.

It is also instructive to consider this subject by comparing the urinary findings in relation to cystoscopic appearances during the succeeding stages of subsidence in certain cases of *B. coli* cystitis as follows —

- 1 Organisms and pus in the urine and obvious cystitis on cystoscopy
- 2 No organisms but pus in the urine and obvious cystitis on cystoscopy
- 3 Neither organisms nor pus in the urine but on cystoscopy patches of cystitis scattered about the bladder
- 4 Neither organisms nor pus in the urine, nor widespread patches of cystitis on cystoscopy but a chronic inflammatory state of the front of the trigone, bladder neck, and posterior urethra (urethro-cervico trigonitis)

The last condition can often be found many months, and even a year or more, after the attack of acute cystitis has passed, it is commonly accompanied by chronic frequency of micturition, bouts of increased frequency, and sometimes urgency and dysuria and even further attacks of cystitis.

The absence of positive findings in the urine commonly causes the existing chronic inflammatory state in the vicinity of the bladder neck to be overlooked, and the symptoms which it produces to be misinterpreted.

The proof of the relationship between the symptoms and the pathological findings is often apparent in the favourable response of the symptoms and the local condition to the treatment applied to the latter.

A flare up into an acute state of the chronic inflammatory focus is often the origin of an attack of cystitis.

A consideration of all these facts calls for the enunciation of the principles that —

An infective process may be present in the urinary tract with an absence from the urine of either pus or organisms or merely organisms, and that many organisms may be present with only a trace of pus.

In a general way gross examples of abacterial urine in spite of a well established urinary tract focus of infection are well known for example in certain cases of renal abscess

The work of Helmholtz and Field (1926) showed by animal experiments that the urine may be sterile although autopsy examination showed active inflammatory processes in the kidney. Runeberg (1921) reported several cases with sterile pyuria in which the nephrectomy specimens microscopically failed to show a tuberculous focus but foci of staphylococci were found in the renal cortex

Caution must be exercised before pronouncing that a urine is abacterial —

- 1 Tuberculosis must be methodically excluded when pyuria exists
- 2 Chemotherapeutic treatment may prevent organisms which are present from growing on culture media
- 3 Faulty technique especially long delay between collection and bacteriological examination may prevent organisms from being detected

On the other hand repeated trauma from a urinary calculus can produce an initial abacterial pyuria so can inflammatory states affecting contiguous structures

The diagnosis of true infective abacterial pyuria should be made only when repeated bacteriological examinations of the urine have been made with great care and are all negative

The fact that many of these cases respond dramatically to treatment with novarsenobillon is suggestive that the cause of the treatment is often a staphylococcal one

The disease has been transmitted to animals by Schaffhauser (1937) without any organisms having been identified. This is strong circumstantial evidence that the cause is an infective one. Moore (1943) who reported a number of cases of abacterial pyuria feels that experiments should be done to determine whether an ultra microscopic virus is not the cause in certain cases

### TREATMENT

**Prophylaxis**—In dealing with a case likely to fall a victim to this infection every precaution must be taken to prevent such an occurrence

EVEN IN CASES WHERE NO INSTRUMENTATION OR OPERATIVE INTERFERENCE IS INTENDED safeguarding advice against infection can often be given to any patient with symptoms of urinary disease. Such a patient may be warned that a sudden strain of any kind as from fatigue sexual alcoholic or dietetic excess or lowering of general health from other causes may be the means of precipitating an attack of urinary infection

Even though infection be already established there must be no relaxation of antiseptic precautions where instrumentation is concerned

AS A PRELIMINARY TO INSTRUMENTATION a course of urinary antiseptics should be commenced a day or so before and continued for four days altogether. Two grams a day of one of the sulphonamides seems in the ordinary way to be adequate

**PRECAUTIONS IN THE PASSAGE OF INSTRUMENTS**—First of all there are the elementary precautions in cleaning the hands and the genitalia which have to be handled. Irrigation of the anterior urethra with an antiseptic is a precaution which some surgeons like to take

The choice of instruments and the skill and care with which they are used can be the most important factors which decide whether urinary (catheter) fever will supervene or not as a result of the instrumentation

If it is the first instrumentation in a male a choice of instruments—with a sterile towel on which to lay them—should be to hand. Ordinary rubber catheters are not the best because they have to be held near the vesical end, and are not necessarily easy to pass. The Triemann catheter (Fig 111, A), however, although of rubber is not only firmer—and, therefore, can be held well away from the tip—but is the easiest of all catheters to pass, size 7 or 8 (English) should be to hand for general purposes. When gum-elastic instruments are used if they are hard and not introduced with a stylet, first of all soften them well in hot water. Do not use large sizes—size 8 English is big enough for general purposes—bicaude as well as coudé should be available. Metal prostatic catheters will sometimes pass when no others will.

**INFECTED BLADDERS CONTAINING RESIDUAL URINE** can often be much improved by a short course of vesical lavage. The need for this is often pressing in cases where the infection is marked and requires surgical intervention.

**BEFORE SURGICAL INTERVENTION IN INFECTED CASES**—General measures to reduce sepsis should be undertaken. It is sometimes wise to postpone operation until sepsis is lessened.

In staphylococcal infections a course of pre operative autogenous vaccine is sometimes desirable (Marion).

Operative procedures in all bad cases of infection must be reduced to the absolute minimum. A pre-operative injection of omnopon and scopolamine or morphia will often reduce the amount of anæsthetic required.

Adequate bladder drainage following all operations on the bladder or the urethra is the most important means of keeping down urinary infection.

**Curative treatment**—Theoretically this may be discussed under several headings, promoting drainage, applying antiseptics, attacking infection from the blood stream, eliminating the absorbed products of infection, dealing with complications.

**PROMOTING DRAINAGE**—In lower urinary tract infection, by suprapubic cystostomy or indwelling catheter.

In certain cases the indwelling catheter is unsatisfactory, especially if it produces prostatitis. It may then require to be replaced by suprapubic cystostomy. A two way tube for convenience of irrigation is a useful appliance.

**APPLYING ANTISEPTICS TO THE INFLAMED PARTS**—Frequent vesical irrigation. A two way tube—either a short or an angled long one—is convenient for irrigating purposes. Where the infection is associated with bleeding giving rise to clots, the long tube is inconvenient. Suitable lotions are mentioned on p 697.

**ATTACKING THE INFECTION THROUGH THE BLOOD STREAM**—The sulphonamides, urotropin, etc., are referred to on p 767.

*Intravenous injections of urotropin* are often beneficial. One gram dissolved in 5 c.c. of sterilized water should be given daily. Up to four such injections in twenty four hours may be tried in septicaemia.

*Penicillin therapy* should be used in suitable cases.

For fluid administration see page 733.

#### TREATMENT OF COMPLICATIONS

*Treatment of digestive troubles*—Gastro intestinal symptoms can be such a prominent feature of a case with urinary infection that they obviously call for a regulation of the diet.

*During a serious phase*—Vegetable soups, and farinaceous solids, such as potatoes and rice, and freshly stewed fruits are indicated.

*When improvement sets in* add milk butter cooked vegetables toast biscuits jain

*When constipation is present* cooked fruits twice a day in addition to laxatives such as cascara

*When diarrhoea is present* omit milk fruit and uncooked vegetables and drinking with meals give bismuth

*When there is much flatus* omit all vegetables and give freshly prepared stewed fruits

*When the kidneys are again working well* add fish or white meat once a day

*Suppurations*—These where accessible should be opened as soon as possible. Viliary abscesses of the kidney must be allowed to take their course

### THE TREATMENT OF URÆMIA BY THE ARTIFICIAL KIDNEY OR BY PERITONEAL LAVAGE

Before discussing the different methods of eliminating toxins from the body fluids in uræmia it should be emphasized that the best reward for the labour of combating uræmia is likely to follow the discovery and proper treatment of the causal factor which is so commonly located in the urinary tract itself. Nor should it be forgotten that it is always essential to dilute and assist in the elimination of the toxins by a copious and properly administered intake of fluid. Fluid administration is sometimes misused badly when intravenous transfusion is given by not keeping a proper check on intake in relation to output.

The conception which was formerly popular that the toxæmia known as uræmia was due solely to a concentration of urea in the body fluids no longer holds.

The concentration of toxic substances which produces the condition may be said to be due to renal insufficiency, extrarenal causes or to a combination of these. The toxins in question are believed to be due to metabolism and of protein origin. Although the nature of the metabolic toxins is not known the latter are considered to be dialyzable and therefore capable of passing through such semi permeable membranes as the peritoneum or capillary walls. A constant relationship between urea levels in the blood and ascitic fluid has led workers in both the experimental and clinical fields to employ peritoneal lavage as a means of combating uræmia. There is however a greater urea clearance with the artificial kidney than with peritoneal lavage but the former method requires a more complicated apparatus.

The apparatus required for the employment of either method is elaborate and expert supervision is necessary otherwise there is little chance of success from their employment.

Apparently the first workers to interest themselves in this problem were Abel Rowntree and Turner who in 1913 removed from the blood of animals by experiment the products of metabolism by dialysis.

### THE ARTIFICIAL KIDNEY

This consists of an apparatus which allows the blood to flow outside of the body through a system of dialyzing tubes.

Nearly all the substances excreted by the urine are in the form of small molecules and can be removed by dialysis but substances such as protein which have large molecules cannot pass through the membrane.

Kolff (1944) claims that with his apparatus it is possible to keep alive patients suffering from uræmia and anuria so long as blood vessels for puncture

are available. He also holds that certain poisonous substances with small molecules such as sulphamethylthiazol may also be removed by this method.

The essentials in an efficient artificial kidney are the following —

A good dialyzing membrane (cellophane)

A good anticoagulant (heparin). The dialysator must spread a small quantity of blood over a large surface, the blood must circulate in a closed system, the blood and the rinsing fluid must be kept in continuous movement, it must be possible to properly sterilize all the parts of the apparatus with which the blood comes into contact. For illustrated details of this apparatus see 'New Ways of treating Uræmia' by Kolff (1947).

### PERITONEAL LAVAGE

The principles of this procedure are simply that a large quantity of rinsing fluid is allowed to run through the peritoneal cavity, and that the peritoneum serves as a semi permeable membrane.

Kolff stresses the point that electrolyte content of the rinsing fluid should be compared not with that of the plasma but of the plasma water. The danger of producing a general œdema emphasizes the need for paying attention to this point.

For details of the composition of the rinsing fluid the reader is referred to Kolff's monograph (1947) on this subject.

Heparin is added to prevent clotting in the tubes of the protein containing fluid flowing out of the abdomen. penicillin may be added to the rinsing fluid when cooled down after sterilizing but it should also be given directly to the patient.

Kolff insists that the rinsing fluid be sterilized in a closed system which must not be opened once it is sterilized. The chances of infection are also reduced by having the reservoirs sufficiently large that frequent change from one to another is not necessary.

There is an inner and an outer tank, each contains salts of different kinds in solutions arranged in certain proportions. The rate of flow must be carefully regulated. 1 litre per hour has proved to be satisfactory. Excessive irrigation certainly produces œdema. It is essential that the inflow and outflow can be interchanged at a moment's notice. There is a special method for cleaning the tubes. Catheters are introduced into the abdomen after punctures with trocars.

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## CHAPTER LXX

### THE MEDICAL TREATMENT OF NON-SPECIFIC INFECTIONS OF THE URINARY TRACT

**T**HE adequate treatment of infection in the urinary tract often calls for the close co operation of physician urologist and pathologist for while medical treatment is often successful by itself it must be based on information provided by the laboratory and may prove to be the prelude to a complete urological investigation

There has, of recent years been a vast amount of research carried out on the problems of urinary antiseptics and the empirical and often incorrect use of patent medicines and ill tested drugs has given way before powerful and effective antiseptics. The indications for and the results that can be expected from the use of each new drug are becoming increasingly known and the treatment of the infected urinary tract now rests on a secure scientific basis

The clinical aspects of urinary infection, the signs and symptoms of pyelitis and cystitis, have been dealt with elsewhere and the difference between an acute and a chronic infection has been stressed. From a therapeutic aspect this difference is often more important than the actual localization of the infection in the urinary tract. Two further points require emphasis: first, the importance of knowing the nature of the infecting organism in any case under treatment, and secondly, the great difference between a simple uncomplicated infection in the urinary tract and one superimposed on some underlying lesion. Even with the powerful antiseptics now available it is uncommon for the urinary tract to be sterilized in the presence of stasis and it must always be remembered that the failure to cure a urinary infection medically is not an indication for despair but rather for a full urological investigation

#### PRINCIPLES OF MEDICAL TREATMENT

There are in the medical treatment of urinary, as of all other infections, two definite aims, the relief of symptoms and the eradication of the infection. While the newer drugs, such as those of the sulphonamide series, succeed in accomplishing both these objectives, some methods of treatment are still entirely symptomatic and must be followed by a determined attack on the infection. Thus it has long been recognized that alkalis will relieve the symptoms of acute pyelitis or cystitis. If sufficient alkalis are given by mouth to render the urine alkaline the temperature will fall and the pain and discomfort will be relieved, but the urine will remain infected and until the infection has been cured, there remains the risk of relapse and complication

**Alkalis in the treatment of urinary infections.**—Adequate dosage of sodium or potassium citrate or bicarbonate is effective in the control of the symptoms of an acute infection, 30 gr of sodium citrate and 30 gr of the bicarbonate are usually given every three or four hours. It is essential to give sufficient to render the urine alkaline to litmus, and the urine should be tested regularly. The treatment should, at first, be given day and night, for if the urine becomes



acid during the night the temperature may rise again. Once the patient has been afebrile for twenty-four hours the dose can be reduced. Alkalis by themselves rarely cure the infection and though the patient may feel perfectly fit a full course of a urinary antiseptic should follow this treatment. In the case of the sulphonamide drugs the two treatments can be superimposed, but mandelic acid or hexamine cannot be given until all alkalis have been discontinued.

The mode of action of alkalis is unknown. The treatment is purely symptomatic and nothing can be gained by treating a symptomless chronic infection with daily doses of citrates. This is still frequently done, but is a relic of the practice prior to the days of efficient urinary antiseptics.

There is little risk in giving these large doses of alkalis for a few days unless there is coexistent renal failure when vomiting and dehydration and the failure to render the urine alkaline may indicate the onset of alkalosis.

The question of the control of the fluid balance of the urological patient has been fully dealt with on p. 733. In the treatment of the infected urinary tract the fluid intake of the patient assumes further importance, for the intake affects not only the hydration of the patient but also the concentration of his urine.

**Fluid control in urinary infections**—It is claimed that the symptoms of an acute pyelitis or cystitis can often be alleviated by "flushing out" the urinary tract, and in acute infections a large fluid intake, of 5 to 6 pints a day, should be given. This may relieve the pyrexia and other symptoms and is a useful adjunct to the use of alkalis.

On the other hand, when a urinary antiseptic is used, a high concentration of the drug is required in the urine and a large urinary output may defeat the object of the treatment. When hexamine or the mandelates are used the fluid intake should be restricted to 2 to 3 pints a day during the exhibition of the drug. This is not an absolute rule and the patient should never be made uncomfortable by too rigid a restriction of the fluids. When the sulphonamide drugs are used, fluids must not be too rigorously rationed, for the acetyl derivatives are not very soluble and tend to precipitate out in the urinary tract. With these drugs relatively small doses produce the required urinary concentration, and an intake of 4 pints a day should be adequate to prevent complications. These figures apply, of course, to temperate climates.

**Urinary antiseptics**—The specific treatment of a urinary infection has as its object the complete elimination of the infecting organism, and for this purpose urinary antiseptics are used. These drugs render the urine bactericidal or bacteriostatic so that multiplication of the infecting organism ceases and the dead and dying bacteria are washed out of the urinary tract. Other means of attack, such as lavage are considered elsewhere, while such measures as vaccines and bacteriophage are now rarely, if ever, used.

Unfortunately there is no one drug which can be relied upon to render the urine bactericidal to all the various organisms which may be found in the urinary tract, and many of the available drugs have toxic effects which limit their use. Before considering the various drugs which are now in use, it will be helpful to consider the properties of an ideal urinary antiseptic.

The IDEAL URINARY ANTISEPTIC should have the following properties —

- (1) It should be effective when taken by mouth in small doses
- (2) It should be non-irritant to the stomach and unaltered in the gut prior to absorption

- (iii) It should be readily absorbed, and
- (iv) Following absorption should produce no general systemic effect
- (v) It should be rapidly excreted by the kidneys so that it has no cumulative toxic effect on the body
- (vi) It should be effective against all the common organisms found in the urinary tract should be bactericidal in a low concentration and should act in both acid and alkaline urines
- (vii) It should be excreted even by a damaged kidney so that an effective urinary concentration can be obtained in the presence of renal failure
- (viii) It should be effective as soon as excreted by the kidneys so that its antiseptic action starts in the renal calyces
- (ix) Neither it nor its breakdown products should irritate the kidneys or urinary tract

Unfortunately no such ideal drug has yet been found and all available antiseptics fail in one or more respects. In order to select the most suitable drug for the treatment of any individual case, it is necessary to understand the potentialities and limitations of each of the available drugs.

Of the innumerable drugs which have been recommended for the sterilization of the infected urinary tract only four groups are in common use to day. These are —

- (i) Hexamine
- (ii) Mandelic acid and its salts
- (iii) The sulphonamide series of drugs
- (iv) The antibiotics—penicillin and streptomycin

**HEXAMINE**—Hexamine (hexamethylene tetramine methenamine urotropine) was introduced by Nicolaier in 1894, and since then has been one of the most widely used urinary antiseptics. It owes its bactericidal power to the fact that in acid solutions it decomposes to liberate formaldehyde. It is, therefore, effective only in acid urines. Some decomposition is inevitable in the stomach, but gastric irritation is rare. It is rapidly absorbed and excreted and produces no general systemic upset. It is given in doses of 10 to 30 gr. three times a day in association with a urinary acidifying agent. Hexamine when properly used is an efficient urinary antiseptic. Its fall into dis-favour was largely the result of careless routine use, for it is essential to render the urine acid and to test its acidity.

Hexamine and acid sodium phosphate are not prescribed in a single mixture, as the hexamine would decompose. In mixture form it should be taken as follows —

Hexamine gr xx  
 Chloroform water to  $\frac{1}{2}$  fl oz  
 Dose  $\frac{1}{2}$  fl oz half an hour before meals

Acid sodium phosphate, gr xx  
 Chloroform water to  $\frac{1}{2}$  fl oz  
 Dose  $\frac{1}{2}$  fl oz half an hour after meals

But to avoid the need for the taking of two different mixtures it is better to give the hexamine in tablet form and the acid sodium phosphate in solution at the same time.

**URINARY ACIDIFYING AGENTS**—For many years acid sodium phosphate ( $\text{NaH}_2\text{PO}_4$ ) was the only salt used for acidifying the urine. Its use is based

on the action of the kidney in excreting acid phosphate salts when counteracting a tendency to acidosis but these salts are not strongly acid and a low urinary pH is not obtainable. Using acid sodium phosphate, a pH of 5.4 may be obtained but rarely will the urine be more acid. The more effective urinary acidifying agents are the ammonium or calcium salts of unmetabolizable acids. *Ammonium chloride* is a powerful agent, owing its effect to the conversion of the ammonium radicle to urea, leaving an excess of acid ions with the resultant production of an acid urine. *Calcium chloride* is similarly effective and probably acts as a result of the immobilization of the calcium ions in the gut. With such salts a urinary pH of 5.0 or even 4.8 can easily be obtained.

The method of combining hexamine tablets with an acid sodium phosphate mixture will not lead to a highly acid urine, and while sufficient formaldehyde may be liberated to act as a prophylactic there will often be insufficient to act as a therapeutic agent. The stronger agents, such as ammonium chloride, given in 10 gr doses with the hexamine, while increasing its efficiency as an antiseptic may lead to the liberation of sufficient formaldehyde to irritate the urinary tract with resultant hematuria and pain. Careful watch is therefore needed on the urinary acidity.

Since the action of hexamine is dependent on a change occurring after its excretion by the kidney, a higher concentration of formaldehyde will be found in the bladder than in the renal urine, and the longer the urine remains unpassed the greater the concentration of formaldehyde. This probably accounts for the favour with which this drug is held by the urologist not only in the treatment but also in the prophylaxis of bladder infection in cases of lower urinary obstruction.

**MANDelic ACID**—Mandelic acid was introduced as a urinary antiseptic in 1935 and soon established itself as an effective agent—replacing the ketogenic diet. Mandelic acid is only active in acid urine, owing its bactericidal action to the free undissociated acid. The less acid the urine, the greater the proportion of ionised mandelic acid and the greater the total concentration of the acid required to produce the same concentration of the free un-ionized acid. Thus while at a pH of 5.0 a concentration of 0.5 per cent of mandelic acid is effective double that concentration is required at a pH of 5.5. If the ordinary dosage of the drug is to be effective, the urine must therefore be highly acid and strong acidifying agents must be used.

The usual dose of mandelic acid is 3 gm four times a day and the three recognized methods of giving the drug are—

- (a) Sodium mandelate (3.4 gm q.i.d.), the urine being acidified by ammonium chloride 11 gm (15 gr) t.i.d.
- (b) Ammonium mandelate (3.4 gm q.i.d.) as a syrup.
- (c) Calcium mandelate (3.4 gm q.i.d.) in powder form.

The latter two being active acidifying agents themselves require no extra ammonium chloride, but whichever method is used it is important to test the urinary acidity.

The urine should be tested with methyl red. A few drops of this indicator added to about 5 cc of the urine in a test tube should give a pink or red colour—indicating a pH of 5.3 or less. Test papers are available for this purpose. It is not, in practice, necessary to test every specimen of urine, it is yet to test the urine each day. If by the second or third day the early morning specimen has a pH of 5.3 or less, no additional acidifying agent is required.

If the urine does not become acid enough on the routine dosage, 1 to 2 additional grammes of ammonium chloride may be given daily and the urine

further tested but often some other underlying cause will be found. The three main reasons for the urine failing to become sufficiently acid are —

- (a) Insufficient acidifying agent
- (b) The presence of renal failure
- (c) Infection with a urea splitting organism

Preparations of calcium or ammonium mandelate are the favourite methods of giving the drug which has an unpleasant flavour and may cause some nausea. It is well absorbed and in patients with normal renal function is rapidly excreted so that toxic or cumulative effects are rare. Slight tinnitus and deafness may occur during the administration of the drug. In the presence of renal failure toxic effects may result not from the mandelic ion but from the systemic acidosis resulting from the unexcreted acidifying agent. Mandelic acid must therefore be used with caution in cases of renal failure and since in such cases a sufficiently acid urine will rarely be obtained the drug is scarcely worth a trial. In the presence of active renal damage as shown by the presence of albumin casts and red cells in the urine acidifying agents may act as renal irritants and though mandelic acid has been used successfully in such cases care is needed. There are no other major contra indications to the drug though as has been mentioned above it is unsuitable for use in an acute febrile case to whom the fluid restriction and acidosis would be an added burden. In routine use the fluid intake should be restricted to 2 to 3 pints in the twenty four hours so that an adequate urinary concentration may be maintained. Mandelic acid is an effective agent against most of the common organisms and is the best drug for use in cases infected with the *streptococcus faecalis*. It is useless in the presence of *B. proteus* (see below).

**THE SULPHONAMIDE DRUGS**—The introduction of the sulphonamide drugs has revolutionized the treatment of urinary infections. Most of the sulphonamide derivatives are rapidly absorbed from the gut and because of their rapid excretion by the kidney large doses are required to maintain an adequate blood level in the treatment of systemic infections. This rapid excretion however leads to far higher concentrations in the urine than are ever found in the blood or other body fluids and in the treatment of urinary infections quite small dosage will lead to a bactericidal urinary concentration. While concentrations of 4 to 15 mgm per 100 c.c. of blood are considered satisfactory in the treatment of general infections urinary concentrations of over 30 mgm per 100 c.c. are easily obtained and levels well over 200 mgm may occur. In fact the urine is often supersaturated with the drug or its acetyl derivative which tends to precipitate out.

Whichever sulphonamide drug is used in the treatment of a urinary infection a dose of 1 gm four times a day is generally adequate though a larger initial dose may be given in severe infections. With this small dosage there is little risk of the drug or its acetyl derivative precipitating out and leading to renal irritation or concretion but the fluid intake must not be too rigidly reduced.

Of the many sulphonamide derivatives on the market five are widely used in the treatment of urinary infections —

- Sulphanilamide
- Sulphathiazole
- Sulphadiazine
- Sulphadimethylpyrimidine (sulphamezathine) and
- Sulphacetamide

Certain minor pharmacological differences between these drugs influence their

most promising features of this new antiseptic agent is its bactericidal action on B protens and it may well prove to be the most effective treatment for infections due to this resistant organism. As with other urinary antiseptics treatment often fails in the presence of urinary stasis and in such cases a streptomycin resistant strain of the organism develops very rapidly—often within a few weeks. For this reason intensive treatment for a short period is stated to yield the best results and dosage as high as 1 to 3 million units per day (1 to 3 gms) has been used. Even in the presence of urinary obstruction streptomycin may hold the infection in check until drug resistance is established and the drug has been used to control infection during operations on infected urinary tracts. This new drug will clearly be widely tried as soon as supplies become available and the indications for its use in urinary infections will then become established.

**OTHER URINARY ANTISEPTICS**—Many other drugs have been recommended as urinary antiseptics in the past. Methylene blue, acriflavine, dyes of the azo series such as pyridium and neotropin and hexylresorcinol have all had their following but few of the many drugs have survived the test of time and competition with the more effective drugs and they call for no mention here. Neotrisphenamine is still occasionally used for one or two injections of an organic arsenical will occasionally clear up a resistant staphylococcal infection of the urinary tract. It has also been recommended in the treatment of sterile pyuria.

Having now considered the available drugs the treatment of the various types of urinary infection may be discussed.

#### TREATMENT OF THE ACUTE URINARY INFECTION

Alkalis should be given at least four hourly (see p 763) and small doses of a sulphonamide (1 gm q.i.d.) should be started. With this treatment most acute infections will subside and if the sulphonamide is continued for a further four to five days after the temperature has fallen a complete cure may be expected. When however the acute symptoms supervene on a chronic infection or as a complication of some unsuspected underlying urological condition the symptoms may be relieved but the urinary infection persists. The further treatment will then be as outlined below. For other measures see p 732.

#### TREATMENT OF THE CHRONIC URINARY INFECTION

In many urological cases a chronic urinary infection may be the presenting and only symptom the underlying lesion being only discovered on full investigation of the case. Yet many cases of chronic pyelitis or cystitis respond rapidly to appropriate treatment. Since modern drugs will cure the majority of the simpler infections and will ameliorate if not cure the infection in the more obviously complicated cases it is justifiable to treat all these cases with a course of mandelic acid or one of the sulphonamide drugs leaving the failures to be more fully investigated. This procedure may appear unscientific but since it saves many patients unpleasant and lengthy investigation it is undoubtedly justified.

Certain investigations should however always be carried out before treating a chronic urinary infection. A full history and careful clinical examination (not omitting the rectal examination) will separate those cases in which immediate full investigation is obviously indicated while the bacteriological examination of a catheter or mid stream specimen of urine will reveal the nature of the infecting organism. The sensitivity of the organisms *in vitro*

If a specimen of urine is sent for bacteriological examination while the patient is still under treatment a false negative or sterile culture may be obtained. Urine passed early in the day may not reach the laboratory until midday and for six hours any surviving organisms have been subjected to the bactericidal *in vitro* action of the drug in the urine. *The real test of cure is that the patient's urine is found to be sterile three to four days after the cessation of all treatment.*

The routine then in the treatment of a chronic urinary infection is as follows —

- (i) Specimen of urine for culture
- (ii) Seven to ten days controlled treatment with the selected drug
- (iii) A specimen may be sent for examination and culture on the eighth ninth or tenth day
- (iv) A specimen must be sent for culture some days after treatment has ceased
- (v) If this specimen is still infected further urological investigation is indicated

#### CAUSES OF FAILURE AND RELAPSE IN THE TREATMENT OF URINARY INFECTIONS

If a urinary infection fails to respond to a properly administered course of a powerful urinary antiseptic or relapses soon after treatment is finished it is essential to try to find the cause of failure. There are five main possibilities to be considered —

(a) **Inadequate or wrong treatment**—It is important to be certain that the correct drug has been used that the routine treatment has been properly carried out (*e.g.* that with mandelic acid the urine has gone acid) and that the persistence of the infection is not due to the survival and multiplication of a different organism. Unless these points are checked the patient may be subjected to a lengthy and unpleasant series of unnecessary investigations.

(b) **Renal failure**—Damaged kidneys are unable to excrete drugs efficiently nor can they form an acid urine. Renal impairment may first be suspected when ammonium or calcium mandelate fails to acidify the urine. The sulphonamide drugs are often effective in the presence of renal failure but the power of sulphonamide excretion falls steadily with failing function and a satisfactory urinary concentration may not be reached. When renal damage has reached the stage in which sulphonamide excretion is impaired it must be remembered that on the usual dose of the drug a higher blood level will result and in severe renal failure not only may a urinary infection remain unchecked by drug therapy but cumulative toxic effects may result if therapy is continued. When a sulphonamide is used in such cases blood and urine levels should if possible be estimated.

(c) **Unilateral renal failure**—A far commoner cause of failure and one that is readily overlooked is the occurrence of unilateral renal failure. In patients with unilateral pyelitis there may be an associated pyelonephritis or some obstructive lesion and while the normal kidney excretes drugs in large quantities the affected kidney may hardly function at all so that no adequate concentration of the drug reaches the real site of the infection. Thus with mandelic acid failure to clear a chronic infection may occur although the mixed bladder urine reaches a low pH because while the healthy kidney passes a highly acid urine that from the damaged kidney may be

to the various drugs can be determined. The urine should also be tested for albumen the presence of which may indicate the advisability of further renal function tests before selecting the urinary antiseptic to be used.

**The choice of drug**—The choice of drug will depend on the nature of the organism on the presence or absence of renal failure and on the general health of the patient.

*B. coli*—All forms of coliform bacilli respond well to mandelic acid or to the sulphonamides. Occasional resistant strains are found but these are rare.

*Staph. albus*—This organism responds well to mandelic acid. Of the sulphonamide drugs sulphathiazole appears to be the drug of choice. In resistant cases one or two injections of 0.3 gm. neoarsphenamine may clear the infection. Penicillin is effective in infections due to this organism.

*Staph. aureus*—This organism is rarely found in a simple urinary infection but may appear in the urine in cases of renal carbuncle, perinephric abscess or prostatic abscess. Penicillin should be used in large doses and may eradicate the disease without resort to surgery.

*Strep. faecalis*—Sulphonamides have little effect on this organism. Sulphathiazole may prove effective but mandelic acid is the drug of choice.

*B. proteus* and other urea splitting organisms such as *B. pyocyaneus*—These organisms are readily killed *in vitro* but prove very resistant to treatment. Mandelic acid is useless and persistence with acidifying agents tends to lead to phosphatic calculus formation in the urinary tract. Sulphathiazole or sulphanilamide should be tried. Streptomycin may prove the best treatment in the future.

It must be remembered that mixed infections occur in the urinary tract and while culture may yield a pure growth of an organism a smear of the urine looked at direct may show two or more organisms. Using specific drugs one organism may be killed off leaving a pure infection with the second calling for a further course of treatment with another drug.

In the presence of renal failure sulphamezathine is probably the best available drug since it is potent in low concentrations in the urine. In such cases and in cases with active renal lesions mandelic acid is contraindicated.

Having selected the drug to be used a full course of treatment lasting seven to ten days should be given. During treatment the patient need not be confined to bed.

**Criteria of cure**—It is essential to have a rigid criterion of cure in the treatment of urinary infections. Thus in the case of an acute infection the relief of symptoms must never be mistaken for cure of the infection. There has been a tendency since the introduction of the sulphonamides to revert to the practice of treating acute pyelitis for a few days—formerly with alkalis alone now with alkalis and sulphonamide—and when the patient is symptom free discharging him as cured. *No patient with a urinary infection is cured unless the urinary deposit shows no organisms and is sterile on culture.* The adequate treatment of the acute will prevent much trouble later from a chronic urinary infection.

The criterion of cure should however be still more rigid. Many infections treated with an efficient antiseptic clear up only to relapse soon after the end of the course of treatment. Such cases may be examples of re-infection but more frequently the infecting organism temporarily held in check by the drug survives and slowly multiplies again when treatment ceases. This may be due to inadequate treatment but is usually associated with the presence of urinary stasis or to a persisting focus of infection in the posterior urethra or elsewhere in the genito urinary tract.

If a specimen of urine is sent for bacteriological examination while the patient is still under treatment a false negative or sterile culture may be obtained. Urine passed early in the day may not reach the laboratory until midday and for six hours any surviving organisms have been subjected to the bactericidal *in vitro* action of the drug in the urine. *The real test of cure is that the patient's urine is found to be sterile three to four days after the cessation of all treatment.*

The routine then in the treatment of a chronic urinary infection is as follows —

- (i) Specimen of urine for culture
- (ii) Seven to ten days controlled treatment with the selected drug
- (iii) A specimen may be sent for examination and culture on the eighth ninth or tenth day
- (iv) A specimen *must* be sent for culture some days after treatment has ceased
- (v) If this specimen is still infected further urological investigation is indicated

#### CAUSES OF FAILURE AND RELAPSE IN THE TREATMENT OF URINARY INFECTIONS

If a urinary infection fails to respond to a properly administered course of a powerful urinary antiseptic or relapses soon after treatment is finished it is essential to try to find the cause of failure. There are five main possibilities to be considered —

(a) *Inadequate or wrong treatment*—It is important to be certain that the correct drug has been used that the routine treatment has been properly carried out (e.g. that with mandelic acid the urine has gone acid) and that the persistence of the infection is not due to the survival and multiplication of a different organism. Unless these points are checked the patient may be subjected to a lengthy and unpleasant series of unnecessary investigations.

(b) *Renal failure*—Damaged kidneys are unable to excrete drugs efficiently nor can they form an acid urine. Renal impairment may first be suspected when ammonium or calcium mandelate fails to acidify the urine. The sulphonamide drugs are often effective in the presence of renal failure but the power of sulphonamide excretion falls steadily with failing function and a satisfactory urinary concentration may not be reached. When renal damage has reached the stage in which sulphonamide excretion is impaired it must be remembered that on the usual dose of the drug a higher blood level will result and in severe renal failure not only may a urinary infection remain unchecked by drug therapy but cumulative toxic effects may result if therapy is continued. When a sulphonamide is used in such cases blood and urine levels should if possible be estimated.

(c) *Unilateral renal failure*—A far commoner cause of failure and one that is readily overlooked is the occurrence of unilateral renal failure. In patients with unilateral pyelitis there may be an associated pyelonephritis or some obstructive lesion and while the normal kidney excretes drugs in large quantities the affected kidney may hardly function at all so that no adequate concentration of the drug reaches the real site of the infection. Thus with mandelic acid failure to clear a chronic infection may occur although the mixed bladder urine reaches a low pH because while the healthy kidney passes a highly acid urine that from the damaged kidney may be



scanty and almost neutral. Similarly a healthy kidney may excrete a urine containing a far higher concentration of sulphonamide than that excreted by the opposite damaged organ.

This unilateral failure is not readily recognized the urea concentration test, urea clearance test and the blood urea may all be within normal limits because of the compensatory overactivity of the sound kidney. A differential renal function test however will soon reveal the real state of affairs and intravenous pyelography, cystoscopy with indigo carmine excretion test or a ureteric urea concentration test should form an essential part of the full urological investigation. A damaged kidney with a superadded infection is a danger to the patient and if the opposite kidney is healthy the infected organ is better removed.

(d) **Nature of the organism—B proteus infection**—Infections with *B proteus* are notoriously resistant to treatment. This organism is of course found most frequently in cases with underlying urinary stasis but even when urological abnormalities are absent it is difficult to eradicate. The organism is readily killed *in vitro* and its resistance in the body is associated with its power of splitting urea with the formation of ammonia. The urine becomes alkaline and cannot be rendered acid even with enormous doses of acidifying agents. The presence of such an infection may be suspected if the urine is persistently alkaline and malodorous and may be proven either by the isolation of *B proteus* on culture or by the use of special urea broth media which aid the detection of urea splitting organisms.

It was hoped that the sulphonamide drugs might prove useful in such infections and some cases do clear up under treatment with sulphanilamide or sulphathiazole but a high percentage of these cases remain resistant to all forms of treatment and are recognized as being among the most difficult of urological problems. Occasionally the infection will die out spontaneously occasionally a superadded coliform infection occurs the *B coli* may then outgrow the *B proteus* allowing the urine to become neutral and mandelic acid may then eradicate the mixed infection. This is unfortunately rare and the treatment of these cases usually consists in trying all available methods in turn but the results are poor and the prognosis bad. Streptomycin may prove to be the answer to this problem.

(e) **Urinary stasis**—The commonest single cause for the failure of treatment is the unsuspected presence of some underlying urological lesion leading to local urinary stasis. Experimental work has clearly shown that a urinary infection can easily be established in animals in the presence of urinary obstruction but rarely in its absence and in man a urinary infection can usually be cleared in the absence of such obstruction but rarely in its presence. If therefore routine treatment fails to cure a urinary infection a full investigation is essential and may disclose an unsuspected congenital abnormality, a hydronephrosis, a calculus or other cause of urinary stasis. Sometimes the cause is inconspicuous—e.g. a mild dilatation of the calyces or small sacculi in the bladder. Often the infection can be easily eradicated after a surgical intervention has removed the underlying lesion and a course of a urinary antiseptic is an essential post operative measure in such cases.

#### THE CONTROL OF URINARY INFECTION IN THE PRESENCE OF URINARY STASIS

Urinary infection in the presence of urinary stasis is difficult to eradicate unless operative measures can remove the underlying lesion. It is therefore

extremely important to prevent the occurrence of infection in such cases and in patients with residual urine whether due to obstructive or neurological causes and in patients undergoing urological or gynaecological operations the prophylaxis of infection assumes great importance

**Prophylaxis of urinary infections**—The catheterization of a healthy bladder carries with it little risk while the catheterization of a patient with residual urine is even in expert hands liable to be followed by infection. Redoubled care is therefore required not only in the sterilization of equipment but in the prevention of local trauma.

Hexamine has long been used in the prophylaxis of urinary infection in such cases. It acts with increased efficiency in the presence of urinary stasis and it can be taken regularly over long periods without leading to any toxic effects. Sulphonamides can be given in small doses (0.5 to 1 gm daily) but are not ideal for prolonged administration. They are very useful as a prophylactic given for a few days before and after a pelvic operation and have been used with encouraging results in gynaecological operations, prostatectomy and plastic genital operations. Mandelic acid is unsuitable for prophylactic use owing to the need of maintaining a highly acid urine.

In the presence of an established urinary infection which has failed to respond to treatment and in which an underlying urological lesion has been found the treatment is in most cases surgical. There are however many cases in which surgical intervention cannot relieve the stasis and in these attempts must be made to keep the infection under control. In those cases in which surgery is indicated it is important to keep the infection at a minimum both before and after operation.

A routine course of one of the sulphonamide drugs will often reduce the bacterial count to a minimum and the administration of small doses of the drug may then keep the infection in check. Two methods have been recommended—the one giving the drug in full doses for one to two days a week and the other the continuous administration of small doses of the drug. Doses as small as 0.25 gm twice a day have been found useful in such cases keeping the bacterial count low and preventing acute relapses. In patients who are elderly or who have damaged kidneys the latter method is the safer. Sulpha thiazole or sulphamezathine can be safely used in such doses over long periods—even in the presence of renal failure. There is a slight risk of toxic side effects and occasional white cell counts and a copious fluid intake are needed. Hexamine has been similarly used but is less effective.

In addition to drug treatment steps should be taken to keep the residual urine at a minimum and bladder lavage is a useful adjunct to the medical control of an incurable infection.

#### MEDICAL TREATMENT IN SPECIAL TYPES OF URINARY INFECTION

**Urinary infection in childhood**—Pyelitis and cystitis are very common in childhood. The principles underlying their treatment are similar to those in adults but care is required in the regulation of the dosage used.

In infancy acute urinary infections complicating an acute gastro enteritis may be severe and fatal. Dehydration must be actively combated and if fluids cannot be forced by mouth parenteral administration should not be delayed. Alkalies in repeated small doses should be given and sulphonamides may be used with caution.

In older children while simple pyelitis is common a urinary infection

is often an indication of an underlying congenital abnormality of the urinary tract. Treatment with a urinary antiseptic should again precede full urological investigation. Mandelic acid is well tolerated by children and the sulphona-  
mides in suitable dosage can also be used.

Sheldon (1943) recommends ammonium mandelate in the form of the following elixir —

Ammonium mandelate gr xxvi  
Ext glycyrrhizæ liq ℥v  
Elixir glusidi ℥ 1/5  
Water to the drachm

For a child aged 1 year 1 drachm may be given twice a day while for a child of ten 60-90 minims four times a day should prove sufficient.

In the case of the sulphonamides Sheldon (1943) recommends the following dosage for children —

AGE	Dose reckoned in tablets of 0.5 gramme (7½ grains)
0-3 months	$\frac{1}{2}$ tablet 6 hourly
3-9 months	$\frac{1}{2}$ tablet 4 hourly
9 months-2 years	1 tablet 6 hourly
2-5 years	1 tablet 4 hourly
5-10 years	1½ tablets 4 hourly
Over 10 years	2 tablets 4 hourly

This dosage is that used in generalized infections and smaller doses are effective in urinary infections. It is only very rarely that a child with acute pyelitis cannot take sulphonamides by mouth and in such cases the soluble sodium salt may be given intravenously or intramuscularly.

**Pyelitis of pregnancy.**—Urinary infection is one of the common complications of pregnancy associated with the gross dilatation of the ureters and the resultant urinary stasis. Acute infections respond favourably to alkalis and sulphonamides and drastic measures such as ureteric drainage or even termination of pregnancy are now rarely required. Postural treatment the patient lying prone with the foot of the bed raised may assist by relieving the pressure of the foetal head on the ureters. Though a sterile urine may be obtained relapse is common and it is rarely possible to eradicate the infection entirely until after delivery. It can however be kept in check either by repeated courses of treatment of a sulphonamide or mandelic acid or by one course followed by an occasional two days treatment. In all cases of pyelitis of pregnancy the urine must be examined in the puerperium and if still infected vigorous treatment instituted.

**Pyelitis in the puerperium.**—An acute relapse of a pre-existing infection and the onset of a new one are common causes of puerperal pyrexia while in many mothers a chronic infection is found to be present the aftermath of pyelitis of pregnancy. The treatment of pyelitis or cystitis in the puerperium differs in no respect from that of the ordinary infection except that in a lactating mother fluid restriction is contraindicated. There is no evidence that either

mandelic acid or sulphonamides cause any harm to the breast fed baby. If the infection persists despite full treatment further investigation is again indicated but may be delayed for six to eight weeks until the involution of the uterus is more advanced and the ureters have returned to normal when a further course of treatment may clear the infection.

**Urinary infection in diseases of the central nervous system**—In diseases of the nervous system in which there is disturbance of the normal mechanism of micturition prophylactic measures should always be adopted to prevent the occurrence of a urinary infection which not only adds to the misery of a bed ridden patient but is one of the common causes of death. The prophylactic measures outlined above are useful—small daily dosage with sulphonamides or hexamine while the greatest care is required to prevent the introduction of infection during catheterization.

If an infection has become established it must be vigorously treated. In early cases with residual urine emptying of the bladder may be assisted by injections of carbachol and a course of such injections (once or twice a day) in conjunction with oral mandelic acid or a sulphonamide may re establish the sterility of the urinary tract.

In retention following transverse myelitis or injuries to the spinal cord suprapubic drainage and lavage should be started early and if an infection is present the fluid used for lavage may be made strongly antiseptic e.g. a 1 to 2 per cent solution of sodium mandelate buffered to a pH of 5.0 may be used in association with a course of mandelic acid by mouth. Tidal drainage may often be used with advantage. Once the infection has been brought under control it must be kept in check by regular treatment and the administration of small doses of sulphamezathine or sulphathiazole is the best treatment for this purpose.

### PROGNOSIS IN URINARY INFECTIONS

As each new drug has been introduced series of unselected cases treated with the drug have been published. It is difficult from such series to assess the relative merits of the drugs for in any series of cases the final cure rate will largely depend on the frequency with which either urinary stasis or impaired renal function is present.

The prognosis of an acute primary attack of pyelitis adequately treated is excellent. The majority of these cases clear rapidly under treatment though an occasional relapse may call for a further course of treatment. In the case of a chronic infection the prognosis depends upon so many factors that no definite rule can be given. Uncomplicated cases can usually be rapidly cured and patients who had suffered for years from a persistent urinary infection have been readily cured by a short course of mandelic acid or one of the sulphonamides.

It is the presence or absence of complicating factors which determines the prognosis of the individual case. Excellent in their absence the chance of cure is greatly diminished by the presence of an underlying genital or urological lesion or of renal impairment. In the presence of urinary stasis the prognosis depends upon that of the underlying lesion. If this can be surgically treated the chance of curing even a chronic and previously intractable infection will be greatly increased.

The nature of the infecting organism must be taken into account for while coliform infections respond rapidly to treatment those due to *B. proteus* are notoriously resistant. Many other factors such as the site of the infection

its duration, the age and general health of the patient and the drugs available for use will also affect the prognosis, which will often finally depend upon the efficiency with which routine treatment is carried out.

When an infection has proved resistant to treatment and the underlying lesion intractable to surgery, the prognosis has, of recent years, been much improved by the possibility of control by the regular administration of small doses of the newer drugs

M L ROSENHEIM.

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## CHAPTER LXXI

### LEUCOPLAKIA AND MALACOPLAKIA OF THE URINARY TRACT

#### LEUCOPLAKIA

THE epithelial lining of any part of the urinary tract may be the seat of a transformation to a stratified type with keratinization. Such a change is referred to as leucoplakia. The disease is found at all ages and in both sexes, but Hennessey (1927), in reviewing seventy-four cases, found an incidence of three males to one female.

**Ætiology**—Certainly prolonged inflammation causes thickened and cornified, stratified epithelium, and because leucoplakia is found commonly in association with inflammation, there is every reason for the belief that the latter condition in some cases causes leucoplakia. That this change is found not uncommonly in the urethra after chronic inflammation, supports this view. But all cases cannot be explained on this theory, because there is no doubt that leucoplakia sometimes precedes the inflammation. This fact has led to a search for other possible causes, and one which has received some support is that the epithelial abnormality is due to a developmental misplacement of cells of the ectoderm.

Experimental and post-mortem investigations have both brought to light another ætiological factor, namely, deficiency disease, especially with regard to vitamin A.

McCarrison (1931), in experiments on animals confirmed the observations of other workers that diets with vitamin A deficiency produce amongst other diseases many instances of keratinization of the epithelium of mucous surfaces.

**Pathological anatomy**—It is found most commonly in the urethra following chronic inflammation there.

More cases are found involving the bladder than the kidneys and ureters, with regard to the last organs the condition is not uncommonly bilateral. It would appear that in certain cases the whole urinary tract is involved in the change more or less simultaneously.

*To the naked eye* the lesion is essentially a whitish area of epithelium which soon becomes dry when exposed by operation. The change may appear as small isolated areas or the mucosa may be involved almost completely.

*Microscopically* all stages between the normal and well developed squamous epithelium may be found if sections are made in different localities. Where the transformation is fully advanced the epithelium shows the characteristic strata from the superficial keratinized layer to the deepest layer of columnar cells, with its tongue like processes which project into the adjacent connective tissue.

Accompanying the leucoplakia are almost always commonplace inflammatory lesions of the underlying tissues and of the surrounding mucosa.

**Symptoms and signs**—The only evidence characteristic of the change is the appearance of cornified squamous epithelium in the urine, but as chronic inflammation of the urinary tract is so often present as well, symptoms

indicating its presence are usually the dominating feature of the case, hæmaturia tends to be a prominent symptom

**Diagnosis**—Urethroscopy and cystoscopy are the important means of identification in the lower urinary tract. The characteristic bluish-white or whitish patches are unmistakable when seen.

When the bladder is too irritable to allow the latter procedure it may be impossible to establish the diagnosis without opening the bladder, as in a case reported by the author (1932).

**Prognosis**—The future is generally one of progressive deterioration in relation to symptoms indicating inflammation, with the ultimate prospect of the development of carcinoma. The case reported by the author in 1932 died in 1941 of carcinoma of the bladder.

**Treatment**—When in the urethra, the treatment is that for chronic urethritis which is invariably present.

Lesions in the bladder can sometimes be attacked with success by light fulguration through a cystoscope. Failing this, localized patches may require excision through a suprapubic approach.

In the renal pelvis the condition can only be discovered by operation. In such circumstances it may be advisable to establish permanent nephrostomy, especially if there is a likelihood of the condition being bilateral. The latter danger will call for restraint in considering the question of nephrectomy.

### MALACOPLAKIA

Malacoplakia is a condition characterized by slightly raised yellowish plaques occurring in the mucosa of the renal pelvis, the ureters and the bladder. The cause of the change is unknown.

**Ætiology**—Malacoplakia is indeed a rare disease and only a few cases have been reported. Thomson Walker and Barrington reported a case in 1923. It has been observed more often in women than in men and after middle life. Cases in young children have been reported, however, by Oppermann (1924)—a girl of eight, and by Morison (1944)—a girl of six. It seems to belong to the inflammatory group of diseases rather than to that of new growths. It is always associated with inflammatory states in the urinary tract, and with a poor state of general health.

There is no unanimity of opinion as to the nature of the inflammation. Exhaustive investigations have failed to establish the condition as tuberculous. Marion (1935) thinks it is probably an inflammatory condition which has been modified because of some alteration in the urine, which renders it specially irritating.

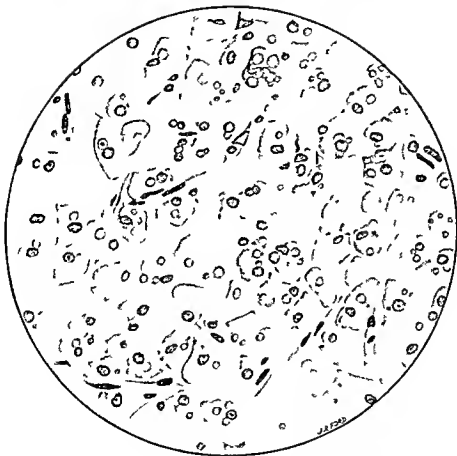
**Pathological anatomy**—Malacoplakia has been observed most commonly in the bladder (Fig. 377, A) but it is not necessarily confined to this organ, which may share the change with the ureters and renal pelvis.

Some of the plaques may be no larger than  $\frac{1}{8}$  in., others may be of considerable dimensions occupying nearly the whole of the affected mucous surface. The smaller patches tend to be elevated to the extent of having a small stalk and an umbilicated aspect of the summit. The vesical mucosa surrounding the yellow patch is sometimes reddened while elsewhere on the mucosa commonplace lesions of inflammation are to be seen.

The principal histological features of a plaque may be described as follows immediately below the overlying epithelium and separated from the muscular coat by submucous areolar tissue are to be seen capillary blood vessels, lymphocytes, polymorph leucocytes, plasma cells, and fibrous tissue cells, together



A



B

FIG 3/7

Coloured drawings (A) of malacoplakia lesions as seen with a cystoscope and (B) of a paraffin section of one of the lesions stained with Ehrlich's hematoxylin and eosin as seen with a Zeiss DD objective. The characteristic cells are large with a finely reticulated faintly eosinophil cytoplasm. The nuclei are deeply stained and generally situated eccentrically. One or more Michelson-Gutmann bodies are present in most of the cells; they stain less deeply than the nuclei. The patient was a woman of 43. She had had frequency of micturition and pain and bleeding at the end of micturition for six months. (Mr P. J. P. Barrington's case.)



with large (malacoplakic) cells and small rounded entities—Michaelis Gutmann bodies (Fig 377 B). The large cells which are characteristic of the lesion contain abundant eosinophilic and granular cytoplasm and have one or several nuclei. Organisms are sometimes seen within these cells and are generally cocciform bacilli but tubercle bacilli have also been found. In the cytoplasm of some of the cells are the distinctive Michaelis Gutmann bodies, generally lying within a vacuole. These bodies are sometimes found lying free in the stroma. Many of the larger of these bodies contain small amounts of iron or calcium which may present a laminated appearance.

Vesical epithelium covers the whole plaque except the summit. The lesion involves the mucous and submucous layers but not the muscular coat which may, however show evidence of inflammation.

**Symptoms, signs and diagnosis.**—The symptoms are those of chronic urinary tract infection. The diagnosis is established by cystoscopy, which enables the yellowish umbilicated projections to be seen side by side with areas of commonplace cystitis.

**Treatment.**—This will follow the lines laid down for cystitis or pyelonephritis, especially of the chronic types and does not offer chances of any great success. There are two reasons for this: one that the general condition of the patient is poor because of an advanced state of chronic cystitis and the other because the disease may be complicated by carcinoma or tuberculosis of the urinary tract.

H P WINSBURY-WHITE

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## CHAPTER LXXII

### NON-SYPHILITIC AND NON-GONOCOCCAL VENEREAL LESIONS OF THE MALE GENITALS

THE lesions covered by the title of this chapter are erosive and gangrenous balanitis, chancroid or soft chancre, granuloma venereum, and lymphogranuloma inguinale. (See also Urethritis.)

#### EROSIVE AND GANGRENOUS BALANITIS

Erosive and gangrenous balanitis is sometimes called the fourth venereal disease. It is an acute erosive and ulcerative inflammation of the lining of the preputial sac, the coronal sulcus and surface of the glans penis caused by infection with the fusiform bacilli and coarse spirochetes found in Vincent's angina of the throat, and is believed often to be due to contamination of the parts with saliva in unnatural sexual practices. As these organisms flourish in anaerobic conditions, an important predisposing cause is phimosis, whether natural or caused by subpreputial lesions such as chancroid, syphilitic chancre, etc.

**Symptomatology**—In its milder forms the mucous surface of the prepuce, the coronal sulcus and the glans are eroded in small patches which appear white. In the more severe cases the erosions are succeeded by red rimmed ulcers varying in size from a pea to a silver threepence or larger, covered with a yellowish white diphtheritic membrane. In still more severe cases the ulcers become gangrenous, eating deeply into the prepuce, which becomes black and may perforate or even slough off. At the same time large portions of the glans may be destroyed.

Externally the appearance varies with the severity of the underlying condition. In the milder cases there is some oedematous swelling and reddening of the skin, and a thin yellowish white offensive discharge oozes from the mouth of the prepuce. In the more severe forms there is greater swelling and discoloration and more offensive brownish discharge, which may be hæmorrhagic. Constitutional symptoms correspond with the severity of the local condition, and in the worst cases there may be high temperature, vomiting and corresponding malaise.

**Diagnosis**—This rests on the ulcerating and possible sloughing with offensive discharge and the exclusion of other conditions such as chancroid, syphilis, etc., which may, however, be associated.

**Treatment**—Cutler *et al.* (1947) have reported good results from instillation, into the preputial sac, of 1 c.c. penicillin, 20,000 units per c.c. The solution was maintained in contact for fifteen minutes and the application was not repeated. The use of penicillin in this disease is based on its anti-spirochetal action. Since the organisms responsible for the condition flourish best in anaerobic conditions, oxygen may also be regarded as a specific remedy for it. In milder cases it may suffice to syringe out the preputial sac with hydrogen peroxide, ten volumes, but if the condition does not improve very quickly under any of these forms of treatment, no time should be lost in exposing the surface, if necessary, by taking a broad V out of the dorsum of the prepuce.

## CHANCROID

(Synonym SOFT CHANCRE)

**Definition**—The term is commonly applied to any ulcerative condition of the external genital organs not attributable to syphilis granuloma inguinale gangrenous balanitis tuberculous or malignant disease. Most lesions of this kind are however specific entities due to infection with the strepto bacillus of Ducrey (*Hæmophilus ducreyi*)

**Ætiology**—Ducrey's bacillus is a Gram negative rod 0.5 by 1.5  $\mu$  which occurs singly as diplo bacilli or in chains and is found under the growing edge of the ulcer. It is cultivated with difficulty requiring a medium which is enriched with blood which it hæmolyzes. Infection is usually conveyed in the first instance by sexual intercourse but may occur through accidental inoculation of any part of the skin surface. It is possible though non proven that infection may be conveyed by sexual intercourse with symptomless carriers the reason for this belief being the greater frequency of the disease in men and the fact that the ulcer is so painful as to be likely to make sexual intercourse practically impossible. It is said to be favoured by dirt and certainly seems to be commoner in the lower grades of society than in the higher ones in this country it is much commoner in ports than in inland towns the difference being probably attributable to importation and to the higher degree of infection of the population of dock areas.

**Symptomatology**—The incubation period is very short. Usually the day after infection each site of inoculation is reddened a papule appears and by the third day the papule has become ulcerous. The shape of the individual ulcer varies with the site of inoculation. If this was a follicle as at the mouth of the prepuce or on the glans each ulcer is round raised above the surrounding surface with undermined bright red edges and a base covered with a greyish membrane on the glans such an ulcer may burrow quite deeply and the mouth of the prepuce may be ringed with such ulcers looking like small sea anemones. In other cases alongside these round ulcers are irregular ones produced by inoculation of irregularly shaped areas by the spread of existing ulcers or by confluence. Such ulcers have irregular undermined edges with cribriform bases covered or not with a greyish white membrane. A characteristic ulcer is the fiddle shaped chaneroid occupying the position of the frenum from which it has spread outwards on to the glans or into the prepuce. Any induration is limited to the lesion itself not spreading into the surrounding tissues or knitting the lesion into a rubbery unit such as usually occurs in a syphilitic chancre. The lesion is usually very tender to touch. Auto inoculation especially under the prepuce results in the appearance of ulcers of different ages a characteristic of great diagnostic value.

Unless the condition is properly treated its course may be very slow the ulcers persisting for many months and often spreading until a large area is affected. Fortunately modern treatment is much more effective than formerly.

**Complications**—Phimosis may result from the inflammatory swelling of the mouth of the prepuce. Under a tight prepuce the ulcers may become infected with anaerobic organisms and phagedæna may result.

The commonest complication is suppurative inguinal adenitis. It is often seen when the original ulcer has been quite trivial and has already disappeared its occurrence is favoured by any treatment or condition which interferes with drainage of the genital ulcer. The affected glands swell and become painful the overlying skin is reddened and very quickly suppuration leads

to the formation of a bag of pus there. If left the abscess bursts through the very much thinned skin and a large open sore is produced. This may spread widely and in any case heals very slowly.

**Diagnosis**—The presence of any lesion on the genital organs raises the paramount question of syphilis. Whatever the clinical appearances no consideration should prevent examination of serum from the edges of the sore for *S. pallida*. At the same time it may be useful to gather a specimen from under the edge of the ulcer for examination for *H. ducreyi* and for the Donovan bodies commonly found in granuloma inguinale. A specimen of blood should be tested for syphilitic infection and the test should be repeated at intervals for a minimum of three months. A negative reaction at the outset would not of course exclude syphilis nor would a positive one indicate that the lesion in question was syphilitic but a negative one at first followed by a positive one at a later date would suggest that whatever else a syphilitic infection had occurred on this occasion. In this connection it should be noted that a double infection would result first in the appearance of a soft chancre and later the development in it of syphilitic characteristics.

With the proviso that specimens are taken for laboratory tests and that these do not suggest a diagnosis of syphilis the following may help to distinguish chancreoid from other lesions. An incubation of a very few days absence of surrounding infiltration suppleness and great tenderness of the lesions and a history of their appearance in succession would suggest chancreoid rather than syphilitic chancre or gumma for the distinguishing characteristics of granuloma inguinale from chancreoid see p. 633. Histological examination should serve to distinguish chancreoid from malignant disease or tuberculosis and the size of the ulcers should distinguish them from herpetic vesicles which may show as a crop of ulcers each the size of a pinhead or a millet seed.

The bubo of chancreoid can usually be distinguished from the adenopathy of syphilis by being more acute and by its tendency to abscess formation. It is usually more acute than the bubo of lymphogranuloma inguinale and has less tendency to fistulation. In the absence of a history of similar lesions in the past two skin tests are valuable in distinguishing the bubo of chancreoid from that of lymphogranuloma inguinale. In the Ito-Reenstierna test 0.1 c.c. of a killed culture of *H. ducreyi* is injected into the skin so as to produce a wheal and in the Frei test some killed virus of lymphogranuloma inguinale is similarly injected at the same time control injections are made of the medium in which the respective organisms are suspended. The development of a papule more than 5 mm. in diameter at the site of an injection at the end of forty-eight hours with nothing or at most a very small papule at the site of the control injection indicates infection with the organism which has been injected there. A positive reaction may however result from a previous infection so that the interpretation depends on the history.

**Treatment**—If the sore is hidden the question of exposing it by operation must be considered early on account of the danger of phagedena for the better application of remedies and perhaps for diagnostic purposes. It is best to take a broad V out of the dorsum of the prepuce as this leaves plenty of loose tissue in which the almost inevitable chancreoid infection of the wound may work and yet leave sufficient tissue for any plastic operation that may be needed to improve the appearance of the part after the infection has been eliminated.

The treatment of chancreoid has been greatly simplified by the introduction of the sulphonamide compounds. The oral administration of sulphanilamide

sulphapyridine sulphathiazole, sulphamezathine, or sulphadiazine (3 to 4 grammes daily for ten to fourteen days) may be supplemented by powdering the sore with sulphanilamide as first recommended by M. Lepinay (1938). Penicillin appears to be ineffective.

Vaccine treatment with a killed emulsion of *H. ducreyi* (sold under the name of Dmelcos) has often given brilliant results. The vaccine is given intravenously in doses rising from 0.5 to 4 c.c. or more, a combination of both these forms of treatment may prove more valuable than either alone.

Of the many other forms of treatment in use before the sulphonamide era dusting with iodoform is probably the most effective but the smell of the powder is a serious objection to its use. Spraying with oxygen or washing with peroxide of hydrogen followed by painting with 2 per cent. mercurchrome solution often succeeds in time if the treatment is applied to every part of the affected area. Dusting with any powder or washing with any astringent lotion which tends to interfere with drainage should be avoided as it is apt to provoke the formation of a bubo.

When a bubo threatens to form rest in bed and special measures to promote better drainage of the genital lesion such as wet dressings with hypertonic saline may avert the suppuration. When suppuration has occurred the abscess should be evacuated by aspiration rather than by a free incision as the latter leaves an ulcer which becomes infected with secondary organisms and takes many weeks to heal. The aspiration is best done with a 10 c.c. syringe armed with a stout needle, say No. 18 which is most conveniently introduced at the outer pole of the swelling. If the skin has become so thin that bursting of the abscess is almost inevitable, a small vertical incision, about 3 mm. long at the inner pole serves for evacuation, and drainage can be maintained by the insertion of a small wick of gauze.

### GRANULOMA VENEREUM

(Synonyms G. INGUINALE, G. GENITO-INGUINALE, ULCERATING GRANULOMA)

**Definition**—A contagious disease characterized by a chronic progressive granulomatous ulceration usually of the genital, inguinal and perineal regions, with only slight tendency to spontaneous healing.

**Ætiology**—The causal organism is believed by the majority of workers to be an oval capsulated bacterium (*Calymmatobacterium Donovanii*) discovered by Donovan in 1905 and found in large numbers in the endothelial and mononuclear cells of the lesion. Other workers have advanced reasons for believing that this organism is only a contaminant, its chief competitor for the causal role is Friedlander's bacillus, but the support for this organism is not strong.

Some workers including V. G. Nair and N. G. Pandalai (1934) and D. C. A. Butts (1937), have advanced reasons against the venereal origin of the disease, the chief being its not affecting the sex partner and its frequent occurrence in persons not of sexual age. Butts has suggested that it may be conveyed by pubic lice. Most, including R. V. Rajam (1935), have, however, produced strong evidence that in the majority of cases it is venereal. It is indigenous in many tropical and subtropical countries in both hemispheres and affects coloured people more than white, women more than men. According to de Vogel (1927), in Dutch New Guinea at one time the disease which affected from 12 to 35 per cent of the Marindesian population of various villages, was slowly exterminating this race through its interference with

sexual intercourse and conception. A few cases have been described in persons who have never left Europe.

**Symptomatology**—After an incubation period of a few days a papule forms at the site of inoculation and grows to an indolent granulomatous nodule on the penis, the pubis or the groin. The nodule breaks down and slowly spreads while auto inoculation causes the formation of similar lesions in contiguous parts. The ulceration is superficial and shows only slight tendency to healing in the older parts and the scars readily break down. Ultimately by slow growth over many years the whole genital, inguinal and perineal areas may be affected. The developed lesions are described by Rajan (1937) as of three main varieties. The commonest of these is a granulomatous lesion raised above the surrounding tissue studded with nodular and sometimes papillomatous granulations and with an irregular or serpiginous edge. The second form is more ulcerative and painful like chancreoid with a depressed base, thin edge and a moist pale red surface. It is almost devoid of granulations and gives off an offensive discharge. The third is characterized by excessive formation of fibrous tissue which isolates islands of active disease. The scar tissue often breaks down.

The disease may spread to other parts of the body, for example the lips and mouth.

**Complications**—The entrances to the genital passages may become stenosed and great deformity of the penis may occur from cicatricial contraction.

**Diagnosis**—The vegetative character of the lesion with its fungating appearance, its very slow but relentless progress and the presence of the Donovan bodies in the discharge should suggest a diagnosis of granuloma inguinale. The response to antimonial treatment and negative syphilitic Frei (p. 631) and Ito-Peinstein skin reactions would help to distinguish it from syphilis, lymphogranuloma inguinale and chancreoid. In the forms affecting the perineum unlike lymphogranuloma there is no stricture of the rectum.

**Treatment**—Antimony is a specific remedy for this disease. It was formerly given in the form of tartar emetic of which a 1 per cent solution was given intravenously in doses increasing from 1 to 5 c.c. More recently organic preparations have been preferred and probably the most convenient and effective are sodium antimony pyrocatechyl disulphonate which is sold as a 7 per cent solution under the name of Fouadin and lithium antimony thiomucate which is sold in a 1 per cent solution as anthiomaline. Fouadin is given intramuscularly in doses of 1.5, 3 and 5 c.c. on successive days and then on alternate days in doses of 5 c.c. until 12 to 18 have been given. Anthiomaline is given similarly in doses increasing from 0.5 c.c. by 0.5 c.c. to 2 c.c. two or three times weekly for a course of about twenty injections. Three or more courses may be necessary to guard against relapse.

Protein shock therapy and sulphonamide compounds may help if the response to antimony is not satisfactory. According to Turner (1945) penicillin though not active against the specific micro-organism can be useful in curing the secondary infections which complicate this disease.

### LYMPHOGRANULOMA INGUINALE

(Synonyms: Lymphogranuloma venereum, Lymphopathia venereum, Poradenitis venerea, Nicolas Favre disease, Climatic bubo, etc.)

**Definition**—A chronic contagious disease due to a filter passing virus characterized by a trivial initial lesion usually on the genital area followed

by enlargement and suppuration of regional lymph glands. In some cases fibrous tissue formation and lymph stasis lead to elephantiasoid, ulcerative and fistulous changes in the genito ano rectal area and to rectal stricture. The local symptoms are frequently accompanied by fever, anorexia, arthropathies and almost always by a characteristic allergy of the skin to the virus.

**Ætiology**—The virus is a filter-passer described by Y Miyagawa T Mitamura H Yaoi N Ishu N Nakajima J Okamishi S Watanabe and K Sato (1935) as a granulo-corpuscle which is found in huge numbers within the endothelial cells of the parts affected. It grows with difficulty on chorio-allantoic membrane of embryo chicks but freely on yolk-sacs of the same. Infection in most cases occurs through sexual intercourse but extragenital infection is possible. The question of transmission to the fœtus *in utero* is undecided but probably most infections of infants that have been reported were caused by extra uterine contact. The disease is world-wide but commoner in the tropics than in temperate countries and in negroes, prostitutes and persons of the lower grades of society than in whites and higher class people. Its greatest incidence is in the age periods of greatest sexual activity. The disease is transmissible to most laboratory animals, of which the mouse is most commonly used.

**Symptomatology**—In a male, following infection through ordinary sexual intercourse the incubation period is from a few days to some weeks, usually about a week, and the primary lesion is a small herpetiform non-undurated painless vesicle or ulcer which forms on some part of the penis, generally the coronal sulcus sometimes the prepuce or even within the urethra. Other forms of primary lesion are a papule slightly raised above the surface, or a small nodule in the glans penis communicating with the surface by a small fistula. The primary lesion quickly disappears and is often unnoticed.

The lymph channels become infected, and the dorsal lymphatic may be easily palpable. The characteristic adenopathy, which is inguinal in males infected on the penis occurs in ten to thirty days after infection, one or both sides may be affected. First one gland becomes enlarged and tender, and from this the process spreads to most of the glands in the affected groin, with considerable peri adenitis. The result usually is a lobulated mass in the long axis of the groin, which becomes adherent to the now purplish skin. Soon numerous small abscesses form in the affected glands and discharge through fistulae a thick viscid yellowish-white pus in which no organism can be found by ordinary methods of examination. The mouths of the fistulae show no sign of ulceration or granulation. The process is usually very chronic and may continue for many years. The adenopathy may halt temporarily or permanently after involvement of the first gland, or may not proceed to suppuration after reaching a large size, sometimes many foci fuse to form a few larger abscesses. The iliac glands are also affected and may reach a very large size, but suppuration and fistulation are not so common as in the inguinal glands, on the other hand suppuration and destruction of tissue there may be very extensive as in a case reported by H S Reichle and W H Connor (1935), in which it affected all the retroperitoneal glands and spread to the kidneys and adrenal glands causing a huge psoas abscess and arthritis of the hip.

Interference with lymph drainage produced by the adenopathy may lead to elephantiasis of the genitalia and perhaps the leg.

Constitutional symptoms are usual during the period of glandular invasion.

and can be the most marked feature of the disease they include fever with its usual accompaniments—nausea vomiting and anorexia Rheumatic affections are probably commoner than is usually thought and in some cases hydrarthrosis has been the most prominent evidence of the infection The usual constitutional symptoms last about a week but may be much more prolonged Numerous types of dermatosis have been attributed to this infection and it is not surprising that sometimes cerebral symptoms are seen having regard to the ease with which the brain is infected in animals R V Rajam (1936) has reported a fatal case of meningo encephalitis due to this cause Iritis and ulcerative skin lesions have been reported by Benedek and Olkon (1931) and J P Macne (1941) has described various other eye lesions indicating the susceptibility of the ocular structures to metastatic invasion in this disease

**Diagnosis**—The history of a fleeting primary lesion followed by steady but not violent adenopathy with the development of multiple fistulae and the constitutional symptoms sketched above should suggest this disease rather than syphilis chancreoid tuberculosis or granuloma venereum In any case presenting such signs it is axiomatic that a Frei skin test should be performed some of the virus being injected into the skin of a forearm to form a wheal while another injection is given of the medium of suspension of the virus The antigen for this test may be derived from bubo pus from brain of infected mice as once recommended by Grace and Suskind (1936) or from infected yolk sacs of embryo chicks (lygranum) according to the method of Grace Rake and Shaffer (1940) The result is read in forty eight hours and is regarded as positive if in the absence of any marked reaction at the control site, a papule of 6 mm diameter or more in the case of bubo pus or lygranum or of 7 mm or more in the case of mouse brain antigen forms at the site of inoculation A positive reaction indicates that at some time the patient has been infected with lymphogranuloma inguinale and other evidence must be obtained to determine if the present infection is responsible for the skin allergy which the reaction manifests

Various attempts to evolve a complement fixation test for this disease have met with mixed success but recently C M McKee G Rake and M F Shaffer (1940) have claimed that yolk sac grown antigen lygranum is a good antigen for such a test

**Treatment**—GENERAL—In the pre sulphonamide era the multitude of general remedies recommended for the treatment of this disease was good evidence of the relative uselessness of most of them The most successful were injections of antimony administration of iodides and protein shock therapy by T A B vaccine milk products pyrifur etc and specific therapy in the form of injections of the antigen

Treatment by sulphonamides has proved very successful but must be continued for a number of weeks if relapses are to be avoided Sulphathiazole or sulphadiazine is probably the most tolerable compound for the purpose and is given at the rate of 3 gm a day for the first fortnight followed by 2 gm a day for six to eight weeks due precautions being taken to detect the development of any undue toxic effect A combination of protein shock and chemo therapy is likely to prove better than the latter alone When sulphonamides fail antimony given on the same lines as for G venereum often succeeds Willcox (1946) obtained good results by giving 1 000 000 units of penicillin over a period of three days Smaller doses were disappointing

LOCAL TREATMENT should be conservative especially having regard to the good effect of chemotherapy Wholesale extirpation of glands is to be



deprecated as it is usually unnecessary and is not to be followed by chronic lymph stasis of the parts formerly drained by the affected glands.

Local application of heat and the aspiration of abscesses when they form are usually all the local treatment that is necessary.

I. W. HARRISON.

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## CHAPTER LXXXIII

### GENITO-URINARY TUBERCULOSIS

#### INTRODUCTION

**T**UBERCULOSIS is a generalised infection with focal manifestations. During its invasive stage the attack is lymphogenous and the implantations of tubercle bacilli may be air borne or ingested. If the infection is successful a stage of visceral spread is reached because lymphadenoid resistance has been overcome. The lymphatic system by its centripetal flow empties into the blood stream all organisms which reach the great lymphatic trunks. Thereafter implantations of tubercle bacilli are blood borne to the lungs the bones or joints and other organs. This is a stage of visceral dissemination of the disease. The nature of the lesions produced in the tissues by the tubercle bacillus depends on (1) the number and virulence of the organisms and (2) the resistance of the host. Successful implantation of tubercle bacilli to the tissues of the patient leads to focal tuberculosis. The lesions may be sparse or miliary active or relatively quiescent. Subsequently quiescent foci may become reactivated even after an interval of a number of years.

#### TUBERCLE BACILLURIA

Tubercle bacilluria has been defined as the passage of tubercle bacilli (in a tuberculous subject) through (1) a perfectly healthy kidney (2) a kidney damaged in any way but not tuberculous and (3) a kidney changed by so called tuberculous nephritis (Dimitza and St Kartal 1932). This statement is incorrect.

It was known that tubercle bacilli could be recovered from the urine of patients in which there were neither the symptoms nor the signs of urogenital tuberculosis. In such patients an active extra urinary focus of tuberculous disease was always present (see Table I). Examination of the kidney re-

TABLE I  
REPORTED FIGURES FOR TUBERCLE BACILLURIA

Author	Total Cases	Bacilluria	Per cent	Extra urinary Lesion
Harriss	110	—	2.7	Bone and joints Pulmonary
	49	4	8.8	
Brown	104	—	10.0	
Hobbs	100	—	60.0	
Dimitza and Selaffhner	183	8	4.3	Extra renal Pulmonary
Deist	31	12	38.7	
Killeithner	19	3	15.7	
Lotz	13	3	23.0	
Miller	36	1	33.3	Extra renal Pulmonary
Mack	20	15	75.0	
Band and Munro	174	—	14.4	
Band	300	64	21.3	

deprecated as it is usually unnecessary and is apt to be followed by lymph stasis of the parts formerly drained by the affected glands.

Local application of heat and the aspiration of abscesses when they form are usually all the local treatment that is necessary.

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Dewst	31	12	38.7	Pulmonary
Killeuthner	19	3	15.7	"
Lotz	13	3	23.0	"
Miller	36	12	33.3	"
Mack	20	15	75.0	Extra renal
Band and Munro	174	25	14.4	Pulmonary
Band	300	61	21.3	"

sponsible for the excretion silently of tubercle bacilli usually failed to reveal to the naked eye a focus of infection, whether the organ was removed at operation or autopsy. It was Medlar (1926) who demonstrated by the method of serial sections that bilateral tuberculous lesions of a microscopic nature could be seen in the kidneys removed from patients who had died from extra urogenital tuberculosis. Subsequently, Coulaud (1935) by inoculation experiments provided proof of the relationship of tubercle bacilluria to actual lesions in the renal cortex and medulla. The writer has reported an incidence of tubercle bacilluria in 21.3 per cent among 300 cases of extra urogenital tuberculosis investigated (see Table II). As these patients responded to

TABLE II  
TUBERCLE BACILLURIA INCIDENCE IN SEXES

	Cases	Urine T B Positive	Per cent
Males examined	158	20	12.6
Females examined	142	44	30.9
	300	64	21.3

treatment and the extra urogenital foci of tuberculosis became quiescent, the bacilluria disappeared. The recovery rate over a period of five years was 23.4 per cent (see Table III). On the other hand, the mortality rate in

TABLE III  
TUBERCLE BACILLURIA—64 CASES FOLLOW UP  
RECOVERY RATE IN FIVE YEARS

	Cases	Recovery	Per cent
Males	20	5	25.0
Females	44	10	22.7
Total	64	15	23.4

extra urogenital cases of tuberculosis which suffered from tubercle bacilluria was high—59 per cent (see Table IV) and neither symptoms nor signs of

TABLE IV  
TUBERCLE BACILLURIA—64 CASES FOLLOW UP  
MORTALITY RATE IN FIVE YEARS

	Cases	Deaths	Per cent
Males	20	13	65.0
Females	44	25	56.8
	64	38	59.0

urinary tuberculosis developed. In many of these patients the dissemination of the disease was urinary, and in others repeated reactivation of the original focus provided evidence of an undue sensitization to the tubercle bacillus (Rand, 1942).

### THE MINIMAL AND SUBCLINICAL RENAL LESIONS

**Pathology**—No naked eye lesion can be detected when the kidney from a case of tubercle bacilluria is sectioned and examined (Fig. 378). But if a



FIG. 378  
Whole section. No naked eye  
tuberculous focus visible.

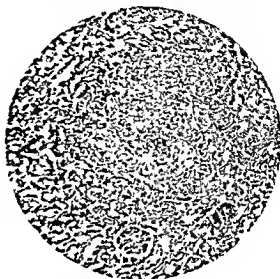


FIG. 379  
Typical mononuclear tubercle affecting a  
glomerulus.

large series of serial sections are cut, stained, and mounted, minute cortical foci of tuberculous disease will be found (see Table V). These lesions are present in all stages from the epithelioid and mononuclear tubercle to the larger follicle with caseation and giant cell formation. In a sanatorium population where the extra urogenital tuberculosis has been active and progressive, the renal lesions are bilateral and cortical. A sufficient analogy may

TABLE V

HISTOLOGICAL INVESTIGATION BY SERIAL SECTIONS OF BOTH KIDNEYS  
FROM PATIENTS WHO DIED FROM EXTRA-UROGENITAL TUBERCULOSIS

Clinical Condition	T B Renal Lesions Positive	T B Renal Lesions Negative	Total
T B bacilluria positive	24	3	27
T B bacilluria negative	0	3	3

The tuberculous lesions when found were always bilateral

be made between a sparse blood borne dissemination of tubercle bacilli in the earlier stages of tuberculosis and the massive miliary spread found in autopsy

records, provided bacilluria alone was present and the urinary lesion was sub clinical. It is concluded that the earliest lesions of the kidney are epitheloid and mononuclear tubercles (Figs 379 and 380). They are found in relation to the glomeruli of the renal cortex (Figs 381 and 382). These primary and sub clinical lesions of the kidney are bilateral. The presence of tubercle bacilli in urine with drawn from the renal pelvis means a tuberculous focus in the kidney. Giant cells appear and there is caseation (Figs 383 and 384). Such caseating foci ultimately ulcerate to the tubules. Dukes (1939) has drawn attention to the constant nature of the pyuria and obvious bacilluria when there is an open renal tuberculosis. In the subclinical lesions however, the bacilli are scanty and their appearance in the urine may be intermittent. The bacilli may invariably be isolated by animal inoculations from adequate samples of urine. Many of these minimal lesions heal (Fig 385). It is presumptive that the disappearance of tubercle bacilli from the urine of tuberculous patients means either (a) healing, or (b) encystment and quiescence in the cortical foci. (a) The healing of a small number of sparsely distributed cortical foci in one kidney would explain the unilateral nature of many cases of caseo cavernous renal tuberculosis. (b) The encystment and quiescence of other subclinical foci



FIG 380  
Tubercle follicle in cortico medullary zone

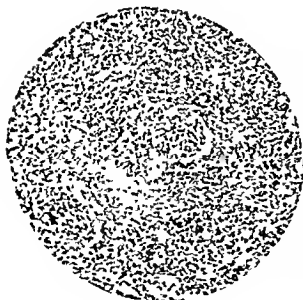


FIG 381  
Early caseation in relation to glomerulus

provide centres of tuberculous disease in a kidney which may later become reactivated under conditions of reinfection or further sensitization from the tubercle bacillus.

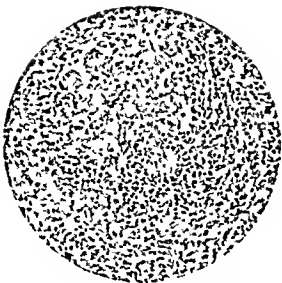


FIG 382

High power view of skin early abscess at periphery of follicle

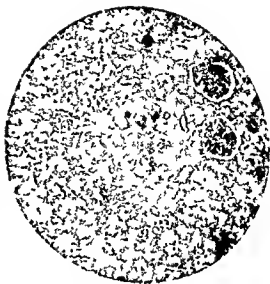


FIG 383

Tubercle follicle with giant cells

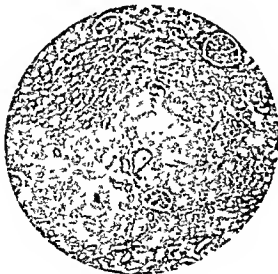


FIG 384

Cavating focus showing giant cells



FIG 385

Healing lesions





A

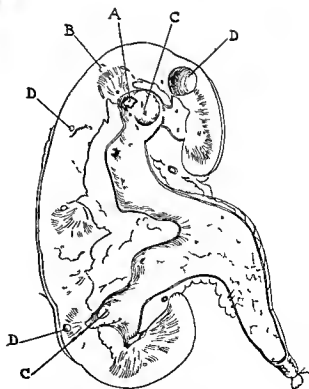


B



C

FIG. 35C  
Legend on page 79.



A, Calcification in tuberculous focus  
B Small focus in cortex  
C Papillary involvement  
D Small congenital cyst

D

**Pathogenesis of Renal Tuberculosis**—The characteristic lesion in an early ulcero cavernous renal tuberculosis is a lesion which has led to cavity formation in the kidney demonstrable by pyelography. Tuberculous debris from cortical foci is discharged to the collecting tubules which converge at the apex of the pyramid. The pyramid and papilla are thus exposed to infection (a) from tubular extension and (b) by direct spread from foci in the



E

FIG. 386

F

Localized fibro caseous lesion in the kidney of a male aged 45 years

- A Retrograde pyelogram left. There is irregularity of the upper minor calyx suggesting early cavity formation. Bacteriological examination. Tubercle bacilli were obtained from specimens of urine from the bladder and left ureter by animal inoculation. Type human.
- B A ray of kidney showing small calcified deposit in upper calyx.
- C Drawing of kidney.
- D Explanatory diagram of drawing.
- E Photograph of whole section.
- F Microscopic report. Eight or nine small, thin-walled, fibro-cavernous tuberculous follicles are present round the margin of the upper calyx. Similar but healed lesions are present in the cortex above. The cyst is smooth-walled and of congenital origin.

cortico medullary zone. The later stages of a confluence of follicles and ulceration at the papilla lead to the characteristic pyelographic changes and the clinical syndrome of renal tuberculosis (Fig. 386 A to F).

#### COINCIDENCE OF URINARY AND GENITAL LESIONS

The association of genital and renal tuberculosis in the male is well known. Menville and Priestley (1938) found coincident renal lesions in 51.6 per cent of a series of 62 cases of male genital tuberculosis studied at autopsy. This figure agrees sufficiently closely with the clinical reports on coincidence of renal and genital foci to raise the question of the pathogenesis of the



FIG 387

Renal tuberculosis male aged 27 years. The bladder wall was congested. The left ureteric orifice was irregularly dilated and retracted. The margins were grossly inflamed and ulcerated. The ureteric catheter was arrested just within the ureteric orifice. Tubercle bacilli were present in the urine.

A Straight X ray. There is calcification in the left renal region.

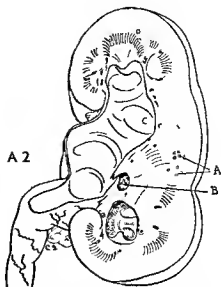
B There is a tuberculous stricture at the lower end of the left ureter. No retrograde pyelogram was possible.

C Photograph of whole section which is that of a tuberculous kidney with a single cavity about its middle. This cavity contained calcified debris now removed. At the lower pole of the kidney there is an area of acute tuberculous invasion in which innumerable tuberculous follicles are present.

D Microphotograph. The appearances are those of tuberculous granulation tissue with giant cell formation.



A 1



- A Small fibro calcious lesions in cortico-medullary zone  
B Calcification in chronic encysted lesion at papilla

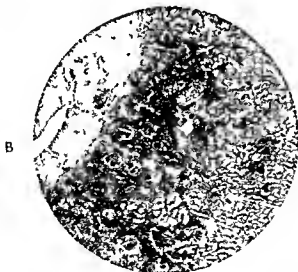


FIG 338

Renal tuberculosis female aged 40 years History of frequency of micturition with transient haematuria Tubercle bacilli present in the urine from the bladder and kidney

- A Drawing of bisected specimen of kidney with explanatory diagram At A at the centre of the cortical zone of the kidney there are a large number of fibro calcious lesions At B there is a breaking down with cavity formation at the apex of the medulla subjacent to A The cavity at the papilla is now communicating with the renal pelvis and in its centre there is a small point of calcification  
B Microphotograph showing tuberculous granulation tissue at the margin of the cavity

association (Hinman 1938) Assuming that a blood borne dissemination of the tubercle bacilli to the viscera has occurred foci of infection in the urogenital systems may appear at three sites (1) in the renal cortex via the renal artery (2) in the prostate or seminal vesicle via the inferior vesical and middle rectal branches of the internal iliac artery and (3) in the upper pole of the epididymis



FIG 389A

The pathogenesis of renal tuberculosis in whole sections  
Whole section of kidney from case of tubercle bacillus  
Minute foci of tubercle follicles seen at A and B

via the artery to the vas deferens from the inferior vesical artery. From these three primary foci in the urogenital system secondary lesions may develop by extension of the disease by the ducts or lymphatics within the system. Thus from the renal cortex tuberculosis may spread by the ureter to the bladder and the urethra thence to the seminal vesicle epididymis and prostate. The primary focus in the vesicle or the prostate readily extends to the epididymis and rarely to the bladder. An initial primary lesion in the

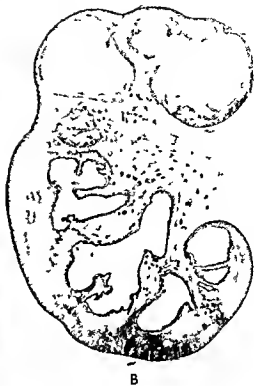


FIG 390

Renal tuberculous male aged 31 years History of frequency of micturition with hæmaturia  
Tubercle bacilli present in the urine

- A The pyelogram is typically that of a tuberculous kidney There is cavitation with a characteristic shaggy outline The line of the ureter is irregular from the presence of tuberculous ureteritis
- B Photograph of whole section of kidney showing the extensive cavitation throughout the kidney
- C Microphotograph showing typical tuberculous lesion with giant cell formation and caseation in the renal cortex

## VESICAL LESIONS

Once tubercle bacilli and the debris from infected foci in the kidney discharge from the tubules to the renal pelvis and ureter, the bladder becomes exposed to the infection. The spread to the bladder is primarily intraluminal,



FIG 391

Tuberculosis of the bladder. The tubercles are greyish yellow in colour. Confluence of the tubercles has led to an irregular shaggy ulcer. The ureteric orifice is slightly irregular and is retracted—golf hole ureteric orifice.



FIG 392

Residual ulceration of the bladder roof—the chronic irritable ulcer of the healing phase.

bladder capacity long after tubercle bacilli and pus cells have disappeared from the urine (Fig 392).

The spread to the bladder is primarily intraluminal, and minute tubercles appear in relation to the ureteric orifice (Fig 391). These tubercles are greyish yellow and tend to become confluent. A characteristic tuberculous ulcer is so formed, the edges of which are ragged and undermined. The surrounding zone becomes one of flame like congestion. Yet, in contradistinction to a generalized cystitis of coliform origin, the more distant parts of the bladder mucosa are uninvolved and of a normal straw coloured appearance. The ureter, though playing a passive part during the phase of intraluminal spread, at the same time becomes involved in the tuberculous process. Tubercle follicles appear in the ureteric wall and by dissemination, by means of the submucous and adventitial lymphatic plexuses, aggregations of tuberculous granulation tissue appear. Fibrosis followed by contracture leads to a shrinkage in the length of the ureteric tube. Thus, in the more chronic cases, in addition to oedema, the presence of follicle and ulceration at the ureteric orifice, there is retraction and gaping of the orifice which is quite characteristic. This is the so called "golf hole" orifice which is retracted upwards and outwards on the ureteric ridge (Fig 391). Tuberculous ulceration penetrates deeply to the vesical mucosa and leads to irritation of the muscular wall of the bladder. The constant contractions and, later, fibrosis of the wall produce a persistent contracture of the bladder which becomes an organ constantly reduced in capacity. Pericystitis and small cell infiltration of all coats of the bladder greatly hinder attempts to increase the bladder capacity during treatment. A chronic solitary and fissured type of ulcer of the bladder roof or lateral wall may lead to continued frequency of micturition with low tubercle bacilli and pus cells have disappeared

## COURSE

Urinary tuberculosis is a progressive disease. The open lesion of the kidney reinfects both that organ and the lower urinary tract. Ulceration and fibrosis of the bladder lead to a contracted bladder. The systolic bladder with thickened and ulcerated walls brings about (a) backward pressure on the healthy ureter traversing the bladder wall, and (b) extension of the tuberculous ulceration to the opposite ureteric orifice, and the possibility of

ascending infection via the ureter and its lymphatics to the remaining kidney. It has been mentioned above that in the initial stages of renal tuberculosis the hematogenous source of the infection renders both kidneys liable to implantations from the tubercle bacillus. The possibility of a secondary invasion of the second kidney from tuberculosis ascending from the bladder raises a new issue. The increased intravesical pressure however in the contracted and systolic bladder which is the site of tuberculous ulceration embarrasses sufficiently the function of the second kidney by backward pressure alone. In a follow up of a short series of late deaths following nephrectomy for renal tuberculosis the writer found that backward pressure on the remaining kidney and hydronephrosis were the principal contributing agents to the fatal issue (Band 1942). Even should the renal tuberculosis be of a bilateral type the one kidney has always shown more advanced caseo-cavernous lesions than the other. In such circumstances free drainage of a disabled kidney will always prolong functional activity. The embarrassment of a contracted bladder leads to backward pressure and further dissemination of tuberculous infection both in the kidney already tuberculous *per primam* from a hematogenous source and that secondarily involved from infection by the ascending route through the ureter or its accompanying lymphatics. Urinary tuberculosis may involve the genital organs by a secondary spread to the posterior urethra the prostate and the vesicle and epididymus. The secondary manifestations of tuberculosis still further draw on the individual's resources whereby he may withstand the ravages of this disease. Summation and additional septic complications take toll of the reserves of an individual's resistance. Meanwhile the original lesion of pulmonary or bone or joint tuberculosis may assume further reactivation and spread. There is no example of so called surgical tuberculosis which demands more awareness of the general repercussions of the disease than tuberculous infection of the genito urinary organs. In the management of urinary tuberculosis the surgeon may with advantage regard himself as the operating physician modifying always the operative procedure according to both the local and general needs of his patient.

#### CLINICAL MANIFESTATIONS

The first symptoms of urinary tuberculosis though primarily renal in origin almost invariably arise from increased vesical irritability. An increased frequency of micturition in a young adult occurring with pyuria in an acid urine form a combination of symptoms and signs which are extremely suggestive of tuberculosis. The frequency is constant both by day and by night and over a period of months it is gradually progressive. There is little or no pain or dysuria. In the examination of the urine the presence of pus cells without organisms in an acid urine is significant. A solitary urinalysis is negligent. The early morning specimen is more likely to yield tubercle bacilli than any other. Samples of urine to be examined by concentration methods and guinea pig inoculation should be submitted to the bacteriologist. Using concentration methods no difficulty should be experienced in demonstrating the tubercle bacillus in adequate samples of urine if there is in fact an open tuberculous lesion of the urinary passages. Pus cells are always present. Confusion with other acid fast bacilli may be avoided by suitable and accurate staining methods. The ultimate proof of the presence of the tubercle bacillus may be obtained by culture of the organism and the data obtained on animal inoculation.



*Hæmaturia* is an inconstant but significant sign in the early symptomatology of renal tuberculosis. The presence of blood in a specimen of urine should never be ignored. A full urological and bacteriological examination should accompany and succeed simple urinalysis.

*Renal pain* may occur occasionally. It is usually limited to a dull ache in the loin. This in turn may be overshadowed by the general malaise of the constitutional upset brought about in any visceral extension of the disease—tuberculosis.

*Pyuria* is so important that a persistent pyuria without obvious cause in a young adult should at once point to a search for some congenital anomaly which could harbour infection or alternatively demand the exclusion of infection from the tubercle bacillus. The urine is acid and the pyuria no more than a definite opalescence to the naked eye. The insidious onset of a cloudy urine may not be appreciated by a patient gradually accustomed to an alteration in his habit of micturition.

**General and local symptoms and signs**—The gradual curtailment in physical fitness in the tuberculous patient may not always receive adequate recognition. Loss of weight, loss of appetite, etc., may be associated with overwork, need for the annual holiday, etc. These are more the complaints of an older age group than those likely to suffer from urinary tuberculosis, and loss of condition, loss of weight, lassitude, etc., are the earliest signs of tuberculosis in any form and in any system in the young adult.

**Clinical signs**—The affected kidney may rarely become so enlarged as would warrant comment during a routine abdominal examination. During the phase of a recent exacerbation in the renal pelvis with associated stasis and renal pain, the combination of pain and renal enlargement may be suggestive. As a rule renal tuberculosis is silent and the symptoms and signs are entirely referable to the bladder.

### DIAGNOSIS

**Bacteriological**—Frequency of micturition and pyuria in the young adult with or without renal pain, hæmaturia, or other localizing symptoms and signs, are always suggestive of a tuberculous infection. The *B. coli* infections of the urinary tract occur like those of the *B. tuberculosis* in an acid urine. *B. coli*, however, are readily demonstrable in a mid stream or catheter specimen of urine, whereas in tuberculous infections isolation of the *B. tuberculosis* may be difficult. Repeated bacteriological examinations of the urine are essential; their omission is negligent. Concentration and cultural methods of isolating the bacillus from twenty-four hour specimens of urine should be employed in addition to the final test of animal inoculation.

TABLE VI  
TYPES OF TUBERCLE BACILLUS IN BACILLURIA

Human	Bovine	Total	Bovine per cent
59	5	64	7.8

**Clinical investigation**—The history of the illness and its insidious onset are important factors. Tuberculosis has a familial and social background which has not been overcome by modern developments in social science. Infection by the bovine type of tubercle bacillus is still significantly frequent in rural districts (see Table VI). Overcrowding and insufficient accommodation for

the segregation of those suffering from open tuberculosis lead to the spread of tuberculosis in the homes of the people and where they work. Small children are doubly exposed to infection from (a) the milk they drink and (b) the dust they inhale as they play on the floors contaminated from droplet infection in their own homes.

**Clinical examination**—The stigmata and symptoms and signs of extra urogenital foci of tuberculosis should be examined. Old evidence of tuberculous lymph glands, bone and joint lesions or a history of bronchopneumonia and pleurisy should be followed up by full clinical and radiographic examinations with the collaboration of the physician. It is well known that a considerable interval of time may elapse between the invasive stage of tubercle in the child and the stage of visceral spread in the adolescent or young adult. It has been mentioned that the visceral implantation which had become quiescent at one time may be reactivated at a later date on account of local or general conditions of lowered resistance.

Although *abdominal palpation* may be unsatisfactory, enlargement of one kidney may occasionally be met with. The palpation of the external genitalia and in particular the *digital examination of the rectum* may yield evidence of genital foci of tuberculous infection. Nodules in the epididymis, thickening of the seminal vesicle and a nodular irregularity and softening of the prostate are more significant of tuberculosis in the young adult than any other pathological lesion.

**Radiographic examination** of the chest, the abdomen and the urinary tract may yield important evidence either (a) of active or chronic pulmonary tuberculosis or (b) calcified mesenteric glands or (c) chronic calcified foci of tuberculosis in the renal regions. Simple radiographs of the abdomen should be taken in two planes, antero-posterior and lateral, and during expiration and inspiration in order to differentiate between intraperitoneal and retroperitoneal lesions.

### CYSTOSCOPY AND PYELOGRAPHY

**Cystoscopy**—These examinations are essential for the exact diagnosis of urinary tuberculosis and to obtain an accurate localization of the lesions, their nature and extent. In tuberculosis the bladder is highly irritable and the patients are young men and women who are often toxic and ill. A preliminary review of the various clinical aspects of the problem should have been made prior to the cystoscopic examination and after the patient has been admitted to hospital. The collaboration of the physician is important. It is unwise and often harmful to undertake instrumental examinations in the presence of toxemia with fever and an elevated blood sedimentation rate. Preliminary sedation and the employment of intravenous pentothal are preferable to low spinal anaesthesia or local analgesics. The urine withdrawn from the bladder is cloudy but offensive. The bladder capacity is always reduced and attempts at overfilling lead to bleeding so that the cystoscopic field becomes obscured. The most striking changes are found in the region of the affected ureteric orifice (Fig. 391). There is a flame-like area of redness and congestion adjacent to the ureteric orifice. Secondary patches of congestion may be present on the interureteric zone and the lateral wall of the affected side or the base of the bladder. The opposite lateral wall and the opposite ureter appear strikingly normal. As the disease progresses small groups of greyish-yellow tubercles appear close to the affected orifice and by confluence these may form an ulcer. The tuberculous ulcer is serpiginous and irregular in its outline. The edges are acutely congested and there is surrounding oedema.

The margins are undermined and the base is covered by a purulent exudate (Fig 391) Attempts at overfilling cause such an ulcer to bleed It is an advantage to employ continuous irrigation throughout the examination The ureteric orifice tends to be drawn upwards and outwards to the lateral wall of the bladder It may be obscured by associated congestion and oedema Chromocystoscopy after the injection of indigo carmine intravenously, may considerably shorten the cystoscopic inspection in search of the orifice The opening itself is often irregular and gaping It may be visibly retracted owing to shortening of the ureter The localization of the disease to one half of the bladder wall and to one ureteric orifice is a striking feature The efflux is

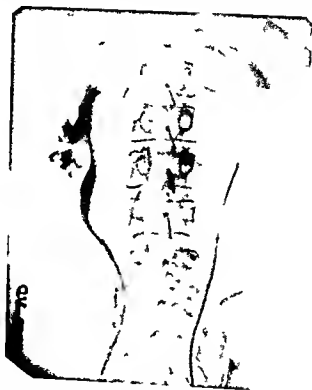


FIG 393

Pyelogram Early tuberculous cavity with ulceration of the lower calyx Typical shaggy outlines

not clear but there is not the toothpaste like discharge seen in septic pyonephrosis Not infrequently a solitary patch of ulceration may be present at the bladder roof This may persist after nephrectomy (Fig 392) and interfere with convalescence on account of an associated and distressing frequency of micturition

**CATHETERIZATION OF THE URETERS**—Considerable controversy has arisen as to whether this part of the examination is really necessary, and the question has been raised as to whether catheterization may not actually do harm Intravenous pyelograms are often sufficiently clear as to be of diagnostic value and when considered under review in association with the bacteriological evidence and the cystoscopic appearances there need be no doubt as to which kidney is in fact tuberculous From the point of view of an accurate assessment of the state of the opposite kidney, however the writer agrees with those who like Emmett and Braasch (1938) insist on the necessity for

catheterization of the ureters and retrograde pyelography. If this examination is not required for the recognition of the tuberculous kidney it is still essential if the state of the opposite kidney is to be properly appraised. A normal pyelogram and a sterile clear urine from the supposedly healthy kidney at the time of the examination make important contributions to the clinical data which should be available to the surgeon before embarking on nephrectomy.

Any danger of carrying tubercle bacilli from the bladder to the healthy kidney by regurgitation along the ureteric catheter is unlikely if overdistension of the bladder and straining are avoided during the examination.

The catheterization of the affected ureter may be rendered difficult not so often by spasm as the ureteric tube in tuberculous is rigid but by tuberculous stricture formation at the intramural portion of the ureter or just above. Such



Fig. 384

Pyelogram. Characteristically irregular positions of calcifications in the kidney.

a finding however may still be of diagnostic value particularly when there is radiographic evidence of a deposit of calcification in the kidney above which points to the chronicity of the infection (Fig. 387). The urine from the infected kidney is always cloudy and sometimes turbid. It is inoffensive. There should be no difficulty in demonstrating tubercle bacilli and pus cells in an adequate specimen of urine (Dukes 1939).

**Pyelography.**—Although intravenous pyelograms are often sufficiently diagnostic the accurate localization of an early ulcerative lesion of a calyx cannot be done without retrograde pyelography. The injection of sodium iodide or diluted pyclectan should be carried out slowly and without force. Overdistension of a tuberculous kidney leading to pyelovenous backflow may precipitate miliary spread. The pyelogram is characteristic. The calyx in the early stages loses its clear cut delicate outline. The cup becomes irregular. The appearance is comparable to the erosion seen radiographically at the margin of the bone in bone and joint tuberculosis. The pyelographic

outlines are often described as shaggy, and they are constantly present when the pyelogram is repeated (Fig 393). As the disease advances, the irregularity spreads from one pole throughout the kidney (Fig 394). The ulcerative lesion proceeds to cavitation (Fig 395). Neither an infected hydronephrosis nor a pyonephrosis provides such typically irregular cavities throughout the kidney as may be demonstrated pyelographically in caseocavernous renal tuberculosis. The coincidence of calcification in the older and more chronic lesions of the kidney is significant. It is to be remembered that such, though quiescent for many years, may sooner or later become reactivated (Figs 396 and 397). Complete calcification with a characteristic reniform shadow in the X ray may be occasionally demonstrable. This is so called autonephrectomy when the ureter of the affected kidney has become sealed by fibrous stricture (Fig 398).

### TREATMENT

The only curative therapy for urinary tuberculosis is nephrectomy in conjunction with the sanatorium life for six months or a year. It is only by surgical removal of the tuberculous kidney that cessation of the continued reinfection of the bladder can be brought about. It has been shown that the constancy of the renal origin in urinary tuberculosis and the frequency of a coincident renal lesion in urogenital tuberculosis, are features of the disease.

**Management—General**—When extra urogenital lesions are present it is essential to have the fullest co-operation between physician and surgeon. It may be advantageous to arrange for the admission of the patient to a sanatorium for complete rest in bed during the period of investigation and assessment of the nature and activity of both extra urinary and urogenital lesions. Even in cases where multiplication of active foci of infection render the need for ultimate surgical intervention problematical, opportunities should be sought for reconsideration of individual cases after an initial period under sanatorium care. Urogenital tuberculosis alone is so slowly progressive that a preliminary course of treatment of two or three months duration may determine (a) the practicability of operative interference, (b) satisfactory immediate post-operative progress, and (c) the ultimate and successful rehabilitation of the patient after a prolonged convalescence.

**NEPHRECTOMY**—The operation for removal of the kidney should be carried out extra peritoneally. A gentle technique with an adequate exposure are essential if the risk of dissemination of the disease at the operation is to be reduced to a minimum. The perirenal fat should be removed with the kidney, otherwise, when cortical groups of tubercles have infected the extra peritoneal tissues the forcing of an imperfect line of cleavage between the renal capsule and the surrounding fat may lead to a tuberculous wound infection with sinuses. Pyelovenous dissemination may lead to a miliary spread and accordingly early ligation of the renal pedicle is advisable during the mobilization of the kidney.

The ureter is a rigid and irregularly thickened tube. It should be mobilized with the immediately adherent perireteric areolar tissues intact. Mobilization beyond the pelvic brim is probably unnecessary. The length of ureter removed should not have been obtained by an operation unduly prolonged, or by an access which required powerful retraction of the wound margins. The employment of two incisions will secure the removal of the entire ureter under vision. The length of the operation time is increased, however, and it is questionable whether the stump of the ureter left behind is of any importance as a source of reinfection of the bladder. Once the kidney has been removed the ureter



FIG 395  
Pyelogram of advanced caseocavernous renal tuberculosis



FIG 396  
X-ray of kidney of Fig 397 after nephrectomy. Note cavitation throughout kidney with calcification at lower pole



FIG 397  
Calcification in kidney in chronic renal tuberculosis



FIG 398  
Calcified kidney—a stonepexy

ulceration and contracture of the bladder do not respond well to nephrectomy. On the other hand when the lesions in the bladder are limited to the ureteric orifice of the affected side and symptoms of frequency and irritation have not been marked the response to nephrectomy may be dramatic. In such cases it may be tempting to spare the patient the loss of time and segregation necessary for adequate sanatorium therapy. Provided a proper sanatorium regimen is followed this may be in order. The building up of an individual patient's reserve in focal tuberculosis cannot be reached by short cuts. Fresh air adequate foods proper bed rest and later graduated exercise for the prescribed period of six months are essential before jeopardizing a patient's future by too rapid rehabilitation. The local treatment of the tuberculous bladder after nephrectomy is of less importance than the general management of the post operative regimen. The persistent residual ulcer may call for local instillations to the bladder of 25 c.c. of 5 to 10 per cent carbolic acid every fourth day. Sometimes as for interstitial ulcers of the bladder roof cystoscopic fulguration of the ulcer margin may be valuable. The very irritable bladders may be soothed by the instillation of 25 c.c. of cod liver oil twice daily. In others a course of tidal lavage with 1 in 1000 proflavine or 1 in 10 000 silver nitrate may reduce the frequency.

### PROGNOSIS

The operation deaths from nephrectomy in renal tuberculosis are negligible if the cases are properly selected and the operation is conducted with gentleness. The recovery rate is good as regards the immediate prospects but as the follow up continues over a number of years recurrences of bladder ulceration reactivation of extra urinary foci or persistent contracture of the bladder and consequent backward pressure on the remaining kidney take their toll. When a complete recovery is taken to mean the rehabilitation of the patient to a full and active life as a wage earner the writer has found that in his own series the recovery rate falls from over 80 per cent to under 60 per cent. The ultimate mortality rate is between 10 and 15 per cent. These figures are comparable with those quoted by Thomson Walker (1936) and Lett (1936). The cause of death is most frequently brought about by renal failure from hydronephrotic dilatation of the remaining kidney. This condition arises from the growing backward pressure brought to bear on the ureter of the healthy side in its passage through the thickened and constantly contracting bladder wall. There is usually a persistent area of vesical ulceration which fails to respond to treatment. Cystostomy leads merely to a tuberculous fistula from the bladder to the abdominal wall. The development of the dilated and tortuous ureter accompanied by hydronephrosis may be followed clinically by means of intravenous pyelograms. When general and local measures to reduce intravesical tension have failed transplantation of the ureter to the bowel should be done if the ureter is still relatively slightly dilated and tests for renal function are satisfactory. Otherwise a cutaneous ureterostomy may yield the patient an expectation of health and comfort for an indefinite number of years provided the ureterostomy tubes and collecting apparatus are properly supervised. The cessation of frequency and pain on micturition and recurrent hemorrhage from vesical ulcers and the gain in strength from proper sleep and free urinary drainage may render cutaneous ureterostomy equally useful when tuberculosis develops in the remaining kidney in the later stages of urinary tuberculosis (Keyes 1940). The problem in tuberculosis of the urinary tract must always be that of obtaining adequate

rest and optimum conditions not only for the patient as a whole, but for his bladder also. The value of a controlled sanatorium regimen can never be over emphasized. Early diagnosis and early nephrectomy may prevent too extensive involvement of the bladder. When general measures are inadequate, and the bladder ulceration not only undermines the general state of the patient by preventing adequate rest, but threatens the function of the remaining kidney early cutaneous ureterostomy may lead to healing in the bladder. This is the result of the defunctioning effect of this operation on the bladder, and the improvement in renal function which follows the free and continuous urinary drainage when formerly there was backward pressure.

### GENITAL TUBERCULOSIS

**Pathogenesis.**—The term urogenital tuberculosis indicates the close association of the disease in the urinary and genital systems. It has been pointed out above (see page 795) that coincident lesions may be demonstrable in the kidney and genital organs in about 50 per cent of cases. The bladder becomes involved sooner or later, whichever system is infected during the stage of visceral dissemination of tubercle bacilli. To be blood borne, a primary lesion of the epididymis should appear at the globus major. The usual site, however for the initial lesion in the epididymis is at the lower pole, which, in fact, is the normal site for infective lesions of the epididymis, other than tuberculosis, which have spread from the posterior urethra via the vas or its accompanying lymphatics. The testis, supplied by an intimately related artery, is never primarily infected by the tubercle bacillus from the blood stream. Extension to the testis is always associated with gross involvement of the epididymis. Associated with tuberculous epididymitis there is, on rectal examination, a high incidence of disease of the seminal vesicles and the prostate. Borthwick (1946) found that in a series of 207 cases of tuberculous epididymitis examined rectally, 87.3 per cent gave evidence of tuberculous prostatitis and seminal vesiculitis. Accordingly it may be accepted that tuberculosis of the genital tract may be (1) primarily hematogenous, or may be (2) secondary to tuberculosis of the urinary tract. There is a tendency for the disease to spread throughout the genital organs so that the lesions are multiple. The seminal vesicles, and possibly the prostate, are antecedent to the epididymis when the disease is first investigated clinically, and the occurrence of bilateral epididymitis is associated with preliminary extension of the disease from one seminal vesicle to the other. Once established in the pelvic genital organs either by implantation of tubercle bacilli from the posterior urethra and spermatic ducts, or from the blood stream, the disease may extend to the lower pole of the epididymis via the lymphatics accompanying the vas. Thereafter tubercle bacilli may invade the vas and pass via its lumen to the seminal vesicle. The testis is invaded from the epididymis by contiguity of spread, and similarly one seminal vesicle may become infected by direct extension from its neighbour. Subsequently the second epididymis becomes involved via the vas or its lymphatics. It was on this assumption of the inevitable extension of tuberculosis that Young (1926) based his operative treatment by perineal extirpation of the seminal tract.

**Clinical manifestations.**—The disease occurs in young males, usually after puberty and when sexual vigour is at its height, i.e. in the 20-30 years age group. There may have been no previous history of symptoms or signs suggestive of tuberculosis in the urinary or any other system. But not infrequently the common prodromal complaints of incipient tuberculosis may



be mentioned *eg* loss of appetite lassitude loss of weight etc Trauma is often cited as a causal agent—but in this respect tuberculosis of the genital tract resembles septic osteomyelitis when a blow or fall is often alleged to precede the infection It is possible that injury by causing a local disturbance may lead to rapid spread in a lesion previously established but dormant or quiescent and minimal

**Symptoms and signs**—The patient invariably complains of a swelling in relation to the testicle The swelling may come on rapidly and may be associated with an effusion into the tunica vaginalis and redness and swelling of the scrotum More commonly however the onset is more insidious The nodule is at the lower pole of the epididymis and is only slightly painful It is hard and may be irregular never quite smooth As the disease progresses the entire epididymis becomes involved It forms an irregular and craggy swelling which later becomes fluctuant The testis may be obscured by an associated hydrocele The skin of the scrotum becomes adherent involved and ultimately breaks down as the cold abscess discharges to the surface Subsequently the swelling may subside and shrink the hard nodular and irregularly misshapen epididymis is still recognized and the tell tale discharging sinus provides evidence of the nature of the disease

Symptoms referable to the urethra or prostate are rare A urethral discharge may occur and urethroscopic and bacteriological examinations should be carried out in order to avoid serious confusion between gonorrhœa and tubercle

**RECTAL EXAMINATION** should be carried out in the knee elbow position A palpably thickened vesicle or an irregular consistency of the prostate is an early sign of chronic infection probably tuberculous As the lesions progress they become characteristically irregular and firm in consistency A cold abscess may form in the prostate and discharge to the urethra or the perineum There is never the association of pain and acute inflammatory reaction with such tuberculous sinuses of the perineum until secondary infection occurs The sinuses are invariably multiple

**UROLOGICAL INVESTIGATION** is always necessary on account of the frequency of associated tuberculous foci in the upper urinary tract *Cystoscopically* tuberculous vesiculitis may lead to œdema and congestion of the bladder mucosa immediately adjacent and later basal cystitis may become quite an obvious lesion associated with the genital infection This is the converse of the clinical and cystoscopic findings in non tuberculous infections of the lower urinary and genital passages

**Treatment**—*Epididymo orchidectomy* is an operation to be deplored The progress of the disease throughout the genital tract is such that a subsequent involvement of the remaining epididymis would lead to complete castration The disease has then been treated by removal of out crops of infection at the periphery The resultant repercussions from the loss of both testes react adversely on the young male both physically and mentally Having regard to the peripheral extensions of the disease from the pelvic genitalia to the epididymes and testes *epididymectomy* has been advised as an operation of choice when the peripheral lesion is limited to the epididymis and the associated testicle is uninvolved This is a treatment which has a considerable vogue but again its object in conserving the testicle for the sake of its presence in the scrotum as well as its internal secretions raises the question of what is to be done with the opposite side Accordingly epididymectomy has been accompanied by contralateral *vasectomy* as a prophylactic measure If this is done as a routine measure many patients may have been rendered sterile

unnecessarily. To sum up it would appear to be quite essential that the operative treatment for genital tuberculosis should be adapted to the individual needs and circumstances of each case. *Epididymo orchidectomy* should be reserved for the advanced cases of testicular involvement where threatened sinus formation unless prevented would add considerably to the toxic absorption to be borne by the patient. *Epididymectomy alone* may be usefully employed when a progressive involvement of the epididymis threatens the testicle. In this respect also signs of irregularity at the distal end of the vas deferens would indicate a route of reinfection to the pelvic genitalia from the periphery via the vas and removal of the epididymis would appear to be indicated. *Vasectomy* would be better reserved for those cases in which a diagnosis of extensive involvement of the pelvic genitalia has already been made the infertility of the patient is practically certain and the object of vasectomy is to protect the remaining epididymis and testicle. The writer does not consider contralateral vasectomy as a prophylactic measure should be carried out when the pelvic genitalia are only slightly involved and there is a prospect of recovery.

**CONSERVATIVE MEASURES**—The insistence on genital tuberculosis forming part of a general visceral dissemination of the disease and the fact that tuberculous epididymitis is a peripheral out crop of infection from the pelvic genitalia should act as a deterrent to hasty surgical interference. The clinical investigation should be carried out under sanatorium conditions the scope should be thorough and leisurely. Extra urogenital lesions and upper urinary tract involvement must be taken into consideration and treated particularly when a well planned regimen may lead to the rehabilitation of a patient who is not necessarily sterile. General treatment should be instituted on sanatorium lines. Locally the scrotum should be supported and a small cold abscess may be aspirated through healthy skin. A small sinus in the scrotum may often dry up and heal under such conditions. There need be no controversy as to when to operate and which operation may be required if the progress of the local genital lesions is watched and checked regularly with the patient's constitutional response to the general therapy for tuberculosis.

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## CHAPTER LXXIV

### GENITO-URINARY SCHISTOSOMIASIS

**DEFINITION**—A disease manifesting itself mainly in the genito urinary system caused by infestation of the venous system of man with *Bilharzia hematobia*—a species of trematode worm of the genus *Schistosoma*

**Historical**—The disease is of considerable antiquity and was recognized by the ancient Egyptians in the mummified bodies of whom evidence of it can still be found

Theodore Bilharz working at the Egyptian State Hospital Kasr El Ainy in Cairo first in 1851 named the causative parasite he had discovered *Distoma hematobium*. In honour of the discoverer the term Bilharziasis commonly replaces that of schistosomiasis

At the same school Looss studied the anatomy of the worm and the pathological changes caused by it. His work was completed by the establishment of the snail as the intermediate host in the life cycle by Leiper in 1915. Australian troops provided Farley (1919) with the opportunity of observing the early manifestations of the disease in human beings not previously exposed to the infestation

**Distribution**—The Nile Valley represents the fountain head of the disease. From here it has spread in Africa along the north coast to the west and then south as far as the River Niger down the east coast to the region of Port Elizabeth. It has been imported into Mesopotamia and to a lesser extent Palestine and Portugal. Sporadic cases are diagnosed in other parts of the world but it is doubtful if infestation occurs in the locality in which these cases are found

It is noted that the distribution in Africa is identical with that of the fresh water eel (*Anguilla*). This suggests the possibility of a second intermediate host still to be established

A feature common to all localities in which the disease is endemic is slow running fresh water e.g. marshes extensive irrigation projects etc. Such moist areas provide a favourable habitat for fresh water snails suit the free swimming stages of the life cycle of the parasite and cause the local human inhabitants to expose themselves to infestation in the course of their agricultural bathing fishing and hunting pursuits. The gross lesions found in the Egyptian fellaheen are due to repeated infestations resulting from exposure in the course of their work in the flooded fields

### ÆTIOLOGY

The causal agent of urinary Bilharziasis is a blood fluke of the family Schistosomidae of species *Hæmatobium*. The species differentiates it from its related diseases—the intestinal and Far East Schistosomiasis caused by the *S. Mansonii* and *S. Japonicum* respectively

The adult worms which are unisexual are found in the venous spaces of the liver portal system and its tributaries most commonly in the prostate

vesical and uterovesical plexuses and sometimes in the vena cava and pulmonary vessels

The tendency of the worms is to swim against the blood stream and so reach venules in the region of the bladder and rectum. Here the worms pair. Each adult is furnished with a pair of suckers, an alimentary, a nervous and a reproductive system. The female is 2 cm in length and is approximately twice the length of the male. The male is broader (1 mm) and the margin of its body folds in a ventral direction to enclose the more filiform female in a gynæcophoric canal. After pairing, the numerous ova are deposited in the ultimate venules. Rapid development of the germinal cell results in the formation of the miracidium enclosed in an egg shell, the product of the vitelline membrane.

The ovum (0.16 mm by 0.06 mm) is terminal spined with the spine pointing in the direction of the blood stream, the fluid pressure of which forces the egg into the tissues. Through these it passes, finally emerging, for the most part in the urine. Contact with water causes the shell membrane, by osmosis, to swell up and burst thereby liberating the miracidium.

The miracidium is an oblong structure with primitive digestive and excretory systems. Its main bulk is made up of germ cells and it moves by means of cilia. Its movements appear to be directed by light and by an attraction to the intermediate host, a snail of the genus *Bulinus*, to which it adheres and by a drilling movement penetrates into the body of the snail. It here encysts producing a morula of sporocysts. Mainly within the liver of the snail the sporocysts develop into cercariæ, which are discharged, generally on the death of the snail, into the surrounding water.

The cercaria is an oval structure with glandular elements, carrying an anterior sucker and an elongated bifid tail, by virtue of which it is able to approach its definitive host—usually man. It is able by a combination of movement and glandular activity to penetrate the skin, and by a process unknown reaches the venous system. At this stage it is known as a schistosomulum, which develops and differentiates into the two sexes of the adult worm.

The cycle from miracidium to cercaria may, under suitable conditions, be completed within fourteen days.

There is some evidence that the adult worms are long lived. Periods of twenty or more years are quoted. Personal observation of cases removed from the likelihood of re-infestation would suggest that after a period of fecundity measurable in months rather than years the worms die. Live ova may persist in the tissues over very much longer periods, though they too, like the worms, exhibit a tendency to die off. The shrivelled eggs and the surrounding fibrous tissue undergo a slow calcification. Mild untreated cases, if observed at intervals cystoscopically, show in the earlier stages areas of egg deposition, which progress to a maximum and which can be mapped. Later observations show changes which can all be accounted for by the transit of eggs to the surface. There is little tendency for the areas to increase in size, number or character suggestive of a fresh deposition of ova.

Similar observations would indicate that the worms are more susceptible to specific treatment than are the ova. In the course of treatment with antimony, a rapid check to the progress of the egg bearing areas, both in size and in number, and a fall in the high eosinophil blood count suggest the death of the egg-laying parents, despite the fact that the ova are still viable. The eosinophil count depends more on living worms than on live ova.

## PATHOLOGY

The essential pathology results from the irritation which the presence of the egg causes in the tissues. The tissue reaction is an inflammatory one centring round the irritant. Round, giant and eosinophil cells predominate to be replaced by fibroblasts. On submucous or subperitoneal surfaces this reaction appears as small nodules or pseudo tubercles which assume with local proliferation of the epithelium a papillomatous appearance. In lesser degrees of infestation the oedema may subside leaving the eggs contained in a membrane altered by fibroblasts. Thus altered the mucous membrane loses its lustre and normal pink colour and takes on a greyish white appearance which has been likened to "sea sand". The ova buried within this mucous membrane are for the most part dead. The shrunken egg envelopes contribute to the "sea sand" appearance and this contribution is enhanced by a deposition of calcium in and around the disintegrating ova.

Associated with the disturbance in blood and lymph supply or with secondary bacterial infection, the mucosa may break down giving rise to ulcerated surfaces. In the urethra this breakdown may be the origin of a urethral fistula—a lesion frequently found in patients in Egyptian hospitals.

**Bladder**—In vesical Bilharziasis, as its name implies, the outstanding lesions occur in the bladder. Due, possibly, to an anatomical configuration of the venous plexuses the areas immediately around the ureteric orifices are sites of predilection. The trigone, base and lateral walls are next involved in that order of frequency. The lesions observable vary with the degree of infestation, its chronicity and the presence of secondary infection. Greyish-yellow tubercles about the size of pin-points, surrounded with a ring of dilated arterioles—a "bladder acne"—are typical of mild early cases, patchy thickening of the mucosa, with catarrhal changes indicates a heavier recent deposit of ova. From these patches the "sea sand" appearance may develop, or, in gross cases, the heaped-up epithelium may change through a granular papillomatous condition to a gross malignancy in a thickened contracted, secondarily infected bladder. Phosphatic deposit and stone formation are common in the later stages of infection.

**Ureters**—As indicated under bladder lesions, the areas adjacent to the ureteric orifices are sites of predilection for ova deposition. The terminal portions of the ureters are to be associated with this tendency. This fact is of clinical import, as the ureteric lesions, occurring in a narrow tube are liable at all stages of the disease to cause obstruction to the passage of urine. In the early stages the oedema resulting from the egg irritation narrows the ureteric lumen. This oedema is later frequently replaced by a cystic change in the ureteric mucosa, a "ureteritis cystica". These small cysts, augmented by a fibrotic contracture of the ureteric wall plus (in the male) a Bilharzial perivesiculitis, form one definite entity in the otherwise debated aetiology of ureteric stricture. The intermittent discharge of lumps of egg containing mucus may completely occlude the narrowed ureteric lumen.

**Kidneys**—Actual deposition of eggs in the kidneys is rare though in heavily infested cases it may occur. The kidneys are however, particularly liable to secondary changes as the result of lower urinary tract Bilharzial pathology. In mild cases in some of which Bilharzia may be totally unsuspected as the underlying cause chronic renal infections with pyelctasis may result from the low ureteric obstruction. In gross cases, with marked bladder changes and sepsis, the kidneys are subjected to back pressure and ascending infection.

to such a degree that kidney failure may be counted the main cause of death from Bilharzial infestation.

**Genitalia and urethra**—Hyperplasia from Bilharzial infection may also occur in the prostate seminal vesicles and bulb of the urethra giving rise to bloody egg containing discharges.

The rectum is commonly involved along with the prostate and vesicles. Perineal and rectal pain and discomfort together with posterior urethral irritation give rise to grave sexual disturbances and neurasthenia. The condition does not respond to the accepted methods of treating prostatitis. Massage aggravates the symptoms and the expressed secretions are mostly blood stained. This sign should be an indication for extra care in the search for ova and if found the institution of specific therapy. In chronic cases vesical neck contracture may need transurethral resection.

Infiltration of the erectile tissue of the penis causes a pseudo elephantiasis with chordeo. Urinary obstruction from stricture terminates frequently in abscess formation and in perineal fistulae. Egg deposition not infrequently occurs in the epididymis and spermatic cord via anastomoses between the veins of the structures and the pelvic plexus of veins. The nodules which develop along the cord and in the epididymis may be confused with tuberculosis. The beading of tubercle is palpable in the vas itself in contradistinction to Bilharzia where the rosary is in the substance of the cord.

In gross infestations masses simulating condylomata and requiring biopsy for differentiation develop in the anal and perineal regions. In the female the cervix uteri and the vagina may be similarly affected.

**Liver and lungs**—Cirrhotic changes in the liver due to the noxious products of the parent worms in the portal system of veins and pulmonary fibrosis from embolic spread from the vesical plexuses via the inferior vena cava have also been recorded.

**Blood**—Venous obstruction may be marked as the result of (1) blockage by the parent worms of the venules and (2) pressure exerted by tissue reaction to egg infiltration. Elephantiasis may develop in a dependent part like the scrotum. It is remarkable that venous thrombosis of pronounced degree occurs so seldom unless caused by secondary infection. Emboli as evidenced by lung fibrosis occur but though these may be frequent they are usually small.

The Bilharzial parasite would appear to possess the common helminthic characteristic that of secreting an anti thrombin product.

The blood count shows a moderate leucocytosis of under 10 000. There is a marked increase in the eosinophil (20 to 25 per cent) and large mononuclears (10 per cent) a small decrease in leucocytes (45 per cent) with the lymphocytes normal (20 per cent). Secondary infection raises the number and percentage of the polymorphs. Treatment or death of the parasites lowers the eosinophilia.

Continued hæmaturia gives rise to a secondary anaemia of the chlorotic type with an average red cell count of 4 700 000 per cubic millimetre colour index 0.95 and hæmoglobin 85 to 90 per cent.

#### CLINICAL PICTURE

The early manifestations of the disease are not pathognomonic and Bilharzia can be suspected rather than proved. They include a local dermatitis at the sites where the cercariae pierce the host's skin and a syndrome of constitutional disturbances characterized by headache rigors fever urticaria

and eosinophilia. These symptoms occur after an incubation period varying from the fourth to the twelfth week of the disease. An interval of months may however elapse before the eggs laid in the walls of the lower urinary passages occasion by their arrival at the mucous surfaces the characteristic symptom and sign of the disease viz an intermittent terminal hæmaturia. This may be associated with frequency and urgency of micturition and a suprapubic or perineal pain. Backache and renal colic are not uncommon. The urine in addition to frank blood contains mucoid threads in which red blood corpuscles and ova can be found. Hæmospermia and a mucoid discharge from the rectum may similarly contain ova as may the vaginal secretions. The disease is self limiting but tends to run a chronic course particularly if untreated or if repeated infestations occur. In mild cases spontaneous recovery ensues. Symptoms may be so slight as to be totally overlooked and the disease may be discovered only in the course of investigation of a chronic renal or prostatic infection. The further course of the disease is influenced mainly by the degree of infestation, obstructive uropathy and the superimposition of infection. Renal damage, general cachexia and carcinoma may be the terminal stages.

### DIAGNOSIS

The finding of ova in the urine or in discharges establishes the diagnosis in gross cases this is not difficult but in milder manifestations may need diligent search. The last few cubic centimetres of urine passed or twenty four hour specimens of urine should be centrifugalized and microscopied. It is essential that the vessels in which these samples are collected should be dry as any moisture tends to disintegrate the ova and to make their recognition difficult. Cystoscopy may be needed to recognize both the typical and atypical bladder changes and to scarify suspected areas and examine the desquamated wash. In some cases actual tissue must be removed via the cystoscope before the ova can be recognized in the biopsy specimen.

Eosinophilia and history of exposure to infection suggest the diagnosis particularly if supplemented by a record of reactions febrile and urticarial occasioned earlier by the toxic excretions and secretions of the developing blood flukes.

Serological tests of the complement deviation type help in the diagnosis and control of the treatment of the disease. The technique is similar to that of the quantitative Wassermann reaction. Macerated liver from infected snails serves as antigen. The test is a group reaction rather than a specific one for *B. hæmatobium*. The difficulties of securing appropriate antigens are such that the test is not readily available in most laboratories. An intradermal reaction of the Casom type can be similarly used as an aid to diagnosis. A filtered saline extract of liver from infected snails is injected intradermally. A positive reaction is shown by erythema and a wheal over the site of injection appearing within twelve to twenty four hours.

Fairley designed such tests in 1917.

**Radiography**—The chitinous envelopes of *Bilharzia* ova are slightly more radio opaque than the average soft tissue. A bladder wall infiltrated with ova may therefore outline on a plain X ray film. Calcification occurring in and around the ova markedly increases this radio opacity and the bladder and ureters then become easily discernible radiologically. The bladder gives an appearance not unlike that of a hydatid cyst undergoing calcification in that the circumference is outlined in contrast with the centre. The ureters in

their lowest thirds show up in well defined outline but the definition may be blurred by associated shadows in the seminal vesicles or other adjacent tissue

Intravenous pyelography is of great value in assessing obstructive changes in kidneys ureters and bladder

The pyelograms show changes conforming to the amount of obstruction in the ureters and to the degree of sepsis these changes are secondary seldom is there evidence of Bilharzia as the prime cause

The ureterograms are mostly complete due to retention of the opaque medium within the ureters Irregular stenosis with dilatation above the obstruction is the characteristic feature This irregular stenosis is confined to the lower portion of the ureters This localization together with an absence of moth eaten appearance in the calyces of the pyelogram differentiates Bilharzia from tuberculosis the length (1 to 3 in.) of ureter displaying irregularity helps to differentiate from stricture not due to Bilharzia stone causing this length of stenosis reveals itself by its own X ray shadow

The cystogram shows changes related to the pathology within the viscus Bilharzia is not diagnosable by virtue of any typical feature in the cystograms

**Cystoscopy**—Bilharzia markedly increases the cystoscopist's problem of differentiating between tuberculosis new growth and pathogenic bacterial lesions

In Bilharzia the lesions tend to be proliferative (Fig 399) in tuberculosis destructive Both commonly occur in the regions of the ureteric orifices (Figs 400 and 401) Tuberculosis localizes along the line of efflux of the urine conforms to the course of the blood vessels tubercles are small and greyish with little or no projection above the surface with a tendency to break down into ulcers all are surrounded with a zone of intense bright hyperæmia in a viscus intolerant of instrumentation Bilharzia is more likely to be related to the proximal side of the ureteric orifice along the line of the intramural ureter or to surround the orifice evenly in a raised lustreless ring studded with large yellowish grey nodules Hyperæmia is a dull red and the line of demarcation from surrounding normal mucosa is sharp Scattered nodules or patches occur in adjacent areas (Fig 402) with no tendency to predominate along the line of ureteric efflux The whole viscus is relatively tolerant to examination In the later stages of fibrosis tuberculosis shows undermining of the ulcer edges and irregular contracture with distortion of the bladder and retraction of the ureter in Bilharzia fibrosis shows itself by patchy pale areas with spiculated surface from which epithelial debris can be scraped—the so called sand patches (Fig 401) The ureteric fibrosis shows little retraction but rather a simple pin point narrowing of the orifice and a loss of capillary coloration In secondarily infected cases the differentiation is more difficult if not impossible but even here areas suggestive if not typical of Bilharzia can mostly be found

With marked proliferation of the epithelium Bilharzial lesions may simulate neoplasm In the ultimate issue simulation may be complete with superimposition of a true malignancy in tissue the site of long standing Bilharzial irritation (Fig 403)

A multiple papillomatosis of Bilharzial origin can generally be recognized by a greyish lustreless surface This loss of lustre is in excess of that presented by neoplasm and is due to the fact that the Bilharzial lesion is covered by a thin layer of adherent muco epithelial debris This can be scraped from the surface with a ureteric catheter leaving a bleeding surface In these scrapings oval mostly in a state of disintegration can be recognized





FIG 399

On the left is a septic ulcer. On the right is a large submucous mass covered with bilharzial tubercles. The rest of the vesical mucous membrane shows signs of inflammation.



FIG 400

Bilharzial nodules. The ureteric orifice is deformed, the surrounding mucous membrane of the bladder is anæmic and has a greenish yellow colour.



FIG 401

Right ureteric orifice with sand patches above it and fused granules forming a membrane below.



FIG 402

To the left of the figure there is a bilharzial ulcer exposed by the disappearance of a pre-existing membrane. Surrounding it are bilharzial tubercles. To the right an ulcer well on the way to healing can be seen in a sacculæ.



FIG 403

Nodular bilharzial carcinoma of the urinary bladder

(Cases of Professor Makar of Cairo. From article by R. Ogier Ward (1945) *Proc. R. Soc. Med.* 39: 97.)

In the removal of small portions of tissue by cystoscopic forceps and the recognition in this tissue under the microscope of disintegrated ova or cell changes indicative of malignancy lies the final differentiation between pure Bilharzia new growth or malignancy supervening in Bilharzial tissue

### PROPHYLAXIS

Preventive measures employed include the following —

(a) **Educational**—Dissemination of information that will lead individuals to avoid infected water for both drinking and bathing

(b) **Sanitary**—Provision of proper sanitary facilities to prevent infected excreta reaching water supply and the purification of all drinking water. The cercariae do not survive longer than about thirty six hours after hatching and water appropriately stored for a period in excess of this may be considered free of risk for large scale purposes. The boiling of water or the addition to it of sulphate of soda for drinking and the addition of cresol (1 to 10 000) for bathing effectively dispose of risk.

(c) **Destruction of the intermediate host**—Water storage tanks should be screened to prevent entrance of the bullous type of snail. Vegetation should be cleared and flood borne vegetable matter should be filtered from all streams to destroy the food supply and the breeding grounds of the snails. The possibility that intermediate hosts exist other than the snail is still an open question.

### TREATMENT

**Specific treatment**—Emetine and certain compounds of antimony have been found to exert a specific lethal effect on the parasite. Many other drugs including salvarsan and perchloride of mercury have been tried.

Sodium antimony tartrate (tartar emetic) first successfully used by Christopherson in 1917 still retains pride of place. Before the use of this drug the disease was considered incurable. Intravenous injections of the freshly prepared solution in saline are given on alternate days. The total dose administered should be 25 to 30 gr. starting with  $\frac{1}{2}$  gr. and working up dependent upon the reaction to  $2\frac{1}{2}$  gr. at each injection. The drug is exceedingly toxic both locally and systemically. Great care must be exercised to insure that the venipuncture is accurate and that the drug is not extravasated into the local tissues or vein wall or sloughing of tissue and sclerosis of the vein will result. An irritable cough coming on almost simultaneously with the injection of the first few drops of the drug into the blood stream may interfere with the successful injection of the full dose. The general toxicity of the drug manifests itself by a cough, vomiting, giddiness, collapse, diarrhoea, jaundice, muscular pains and occasionally sudden death.

Antimonylithine a lithium salt of antimony is supplied in ampoules (0.01 gm. of antimony in 2 c.c.). It can be administered intravenously or intramuscularly. Dosage starts with 15 c.c. and increases to 4 c.c. (proportionately less for children) to a total of 40 to 50 c.c. administered over a period of three to four weeks. Its high antimony content makes it an efficient substitute for tartar emetic. Its toxicity is low and intramuscular injections are painless which makes it particularly suitable for children.

Formidin or neoantimonin a trivalent antimony compound is much less toxic than tartar emetic. It is administered by intramuscular injections from ampoules containing a 7 per cent solution. Ten to fifteen injections are given in a course commencing with 15 c.c. then 30 c.c. and the remaining

doses 5 cc if no toxic reactions have occurred. Results are not so certain as with tartar emetic but the lower toxicity and easier administration make its choice preferable in many cases.

Emetine hydrochloride is given intravenously or intramuscularly in  $1\frac{1}{2}$  gr doses daily for ten to fourteen days. Its toxicity is comparable with that of tartar emetic its therapeutic effect less definite.

**Local treatment**—Drug treatment comprises the use of urinary antiseptics and sedatives surgical measures to combat obstruction to the urinary passages destruction of papillomatous masses and the relief of septic complications such as stone abscess etc.

**Standard of cure**—The aim of curative measures should be at the earliest stage possible to compass the death of the parent worms and the ova by specific drug treatment thereafter or concurrently to execute surgical relief for septic or obstructive complications. The death of the ova and worms can never be prognosticated with certainty but presumption of their death can be adduced by cumulative evidence. This evidence is forthcoming in the abatement of symptoms and signs such as vesical irritability hæmaturia pain and general indisposition. The cystoscopic picture runs parallel with the symptomatic relief in that the bladder lesions give less evidence of acute tissue reaction. The blood picture improves less rapidly but a marked fall in the eosinophil count observed soon after completion of a full course of drug treatment is indicative of success. The complement fixation test is less helpful in that it remains positive in most cases for many years. Repeated microscopic examination of urine and of secretions is imperative in the assessment of effective drug treatment. The ova observable should show first a marked diminution in their number and then evidence of shrivelling and finally complete absence of hatching potentialities and movement of the miracidium within the egg. A high eosinophil count and evidence of viability in the ova six to eight weeks after a course of drugs indicate the necessity for its repetition. It is to be remembered that specific treatment may kill the ova but does not evacuate them from the tissues. As dead foreign bodies they may remain for years slowly working their way to the external surfaces to be discharged partially or completely disintegrated. The fibrosis initiated by the live ova and in a lesser degree maintained by the dead ones may result in narrowing of the urinary passages particularly the ureters. Evidence of this narrowing may only come to light long after the typical symptoms have abated and may be found in the mildest of infestations which constitute the main percentage of Bilharzial patients. These strictures readily respond to dilatation and should be sought for by intravenous pyelography or cystoscopic investigation.

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## CHAPTER LXXV

### HYDATID DISEASE OF THE GENITO-URINARY SYSTEM

**T**HREE per cent of all cases of hydatid disease occur in the kidney, about 1 per cent or less in the retrovesical space. Elsewhere in the genito urinary tract cysts rank as curiosities.

#### RENAL HYDATID

Infestation occurs in childhood. The child's hands convey the ova to the food from the faecally contaminated hair of infested dogs. The embryo of the parasite, *tænia echinococcus*, hatches out in the intestine, and by penetration reaches the portal, then the pulmonary and, finally, the general circulation and the kidney. The intermediate form develops in the parenchyma of the cortex and consists of an ectocyst enclosing a globe of fluid, later filled with scolices and daughter cysts. A fibro cellular layer derived from the parenchyma—the pericyst—surrounds the parasite and expands with it.

Kidney cysts are usually primary and the only ones in the body. Expansion causes the cyst to bulge beyond the surface of the kidney, but it remains intracapsular and is always surrounded by a layer of compressed parenchyma (Surraco, 1937). Inward growth in many cases brings the ectocyst into contact with the base of a papilla, which is absorbed (Fig 404). The parasite then projects into the lumen of the corresponding minor calyx, and may rupture it, discharging scolices and daughter cysts into the pelvis (Fig 405). Some of these pass down the ureter and are voided or may cause retention of urine. Others lodge in various calyces and may form new cysts—the so called calyx cysts.

**Symptomatology**—A closed cyst may cause no symptoms whatever. It may press on surrounding organs, giving rise to pain, breathlessness, diarrhoea or vomiting. A parasite projecting into a calyx may, while still unruptured, produce hæmaturia, frequency, and calyx colic.

With rupture, typical products appear in the urine in the form of hydatid sand or scolices, hooklets, pieces of laminated membrane or daughter cysts. True renal colic occurs. A long symptomless period may supervene or fresh charges of hydatid material come down every few weeks or months. Anaphylactic shock or urticaria may be occasionally observed.

**Diagnosis**—When hydatid products are identified in the urine, they must come from the kidney or the retrovesical space. Very few cysts of the latter rupture and renal colic does not occur. Apart from this pathognomonic sign the diagnosis rests on the presence of tumour in the kidney region, X-ray examination and skin or serum tests. A plain X-ray plate may show a typical ring shadow due to calcification. Cystoscopy may detect a cyst emerging from a ureter or œdema around the orifice. Pyelography in closed cases may show deformity of calyces (Fig 406) or displacement of the ureter, in open ones the typical "goblet" or "crescent" signs (Surraco, 1937, Begg, 1937). Calyx cysts blur the outline of the major calyx concerned, but detached minor calyces are visible. If the whole kidney is involved, none of the intravenous pyelographic medium enters the pelvis and the organ is functionless.

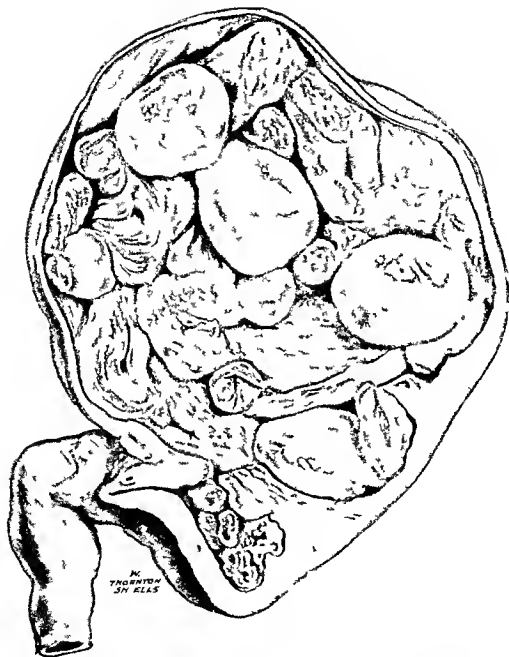


FIG. 401

Hydatid disease of the kidney. All but a fraction of the renal substance has disappeared. The dilated kidney is filled with daughter cysts. Nephrectomy specimen from a man aged 60 who made a good recovery. (University of College Hospital, London)

A Casoni skin test if positive indicates a cyst somewhere in the body. The Ghedini serum test may merely indicate that a cyst has been present at some previous time. Negative tests are of small value. Eosinophilia is erratic.

**Prognosis**—The prognosis of untreated hydatid cyst is difficult to assess. The majority of diagnosed cases call for intervention. Some ruptured cysts cause no further trouble or may, by the constant discharge of fresh material or by sepsis, produce chronic invalidism or endanger life. Active cysts may exist for years and hardly affect the function of the kidney at all. I once

removed the kidney of a woman twenty years after she had first passed daughter cysts, and the organ was practically unimpaired in spite of two secondary calyx cysts. Nicaise (1914) collected 215 cases, none of whom had received any surgical treatment whatever. Of these only 16 had died from the direct or indirect effect of the hydatids.

On the other hand, many of the larger cysts cause chronic ill health through pressure on neighbouring organs, impairment of renal function, blocking of the bladder outflow or sepsis. The last complication not only produces general toxæmia and threatens the other kidney but also gives rise to such pain and frequency of micturition as to exhaust the patient. Even in such cases as these, early diagnosis and well executed treatment will lead in most cases to good results, as the remaining kidney is unimpaired.

**Treatment**—Treatment is either to do nothing or to operate. The prerequisite to decision is the obtaining of a complete knowledge of the topography and function of both kidneys. Where a small cyst has ruptured, the contents have been evacuated, there is no sepsis and the patient is symptom-free, it may be sufficient to check up the state of the kidney from time to time. In other cases it is advisable to

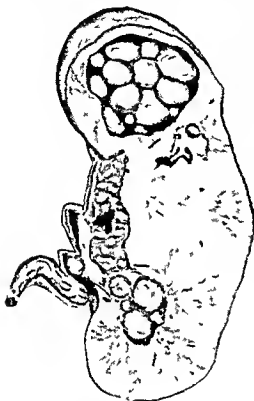


FIG. 405

Kidney sectioned showing the two calyceal cysts with their contained daughter cysts. Both ectocysts are intact. The small cyst seen in the pelvis has come from the middle calyx, the upper corner of which may be seen just below the cyst of the upper calyx. Papillae may be seen in relation to both cysts.

operate, provided the other kidney is not involved and normal in function.

The purpose of the operation is to rid the patient for all time of further urinary symptoms. Nephrectomy is therefore, in my opinion, the procedure of choice in nearly all cases, because of the frequency of secondary calyx cysts which no conservative operation will disclose. In certain types which protrude from the surface of the kidney and are almost pedunculated, with a complete absence of a history of urinary symptoms, partial nephrectomy with the removal of the pericyst may be justified.

Where total nephrectomy is impossible owing to dense adhesions, the ureter should be tied off and the part of the kidney which does not bear the cyst, freed. This should be carried out by the subcapsular method. The

enucleation should then be continued—still subcapsular—until dense adhesions are encountered around the cystic part of the kidney. The aim is to remove all secreting renal substance so that no urinary fistula can persist and to shut off the area of the parasite from the urinary tract. When the limits of safe dissection have been reached the part freed should be removed. This opens the cyst. The ectocyst is pulled out together with all loose hydatid material. The remains of the pericyst are scrubbed with 10 per cent formalin taking



FIG. 406

Pyelogram of kidney with hydatid cyst. Injected after the kidney had been removed.

care that no excess of the fluid passes beyond the area being treated. Rubber dam drains are passed to this area and the wound closed except for these. The drains are removed on the second or third day. This procedure will give permanent cure in many cases. If the hydatid recurs it will only be after a long period and then as a subcutaneous cyst with no detrimental effect on any vital organ and without influence on the urinary system.

On no account should there be any endeavour to avulse the pericyst from any tissue or organ to which it is intimately adherent. There is no line of cleavage and the danger is infinitely greater than that caused by the hydatid itself.

## CHAPTER LXXVI

### ACTINOMYCOSIS OF THE GENITO-URINARY SYSTEM

**A**CTINOMYCOSIS may occur in almost any part of the genito-urinary system. It may be primary in the kidney but is almost invariably due to direct extension from pelvic or abdominal lesions when it is encountered in the bladder. Isolated instances have been met with in the testicle, prostate, seminal vesicle and glans penis. In these parts there is a strong tendency to fistula formation. The disease if it appears in the scrotum or prepuce differs in no respect from cutaneous manifestations elsewhere. The general methods of treatment are more or less standardized apart from the situation of the disease. Palliative surgical measures may be required according to the organ affected. For purposes of this chapter the subject will be adequately covered by giving some details of the nature of the infecting agent and its manifestations as it occurs in the kidney.

#### RENAL ACTINOMYCOSIS

A number of instances of "primary" actinomycosis have been recorded. The term "primary" is useful to distinguish the condition from that in which the kidney is invaded and destroyed by direct extension from the bowel or liver. It is doubtful, however, if it can be considered appropriate. The disease, like tuberculosis, is a systemic one conveyed both by the blood stream and the lymphatics. Unlike tuberculosis, however, it is extremely resistant to the normal protective mechanism of the tissues. The primary focus of renal tuberculosis may have undergone spontaneous cure and the patient enjoy robust health. In actinomycosis, on the contrary, the original focus, though often obscure, probably remains active, and causes considerable disability before there are any localizing signs in the kidney. The number of cases in which an operation on the appendix, followed by a persistent sinus, has preceded the diagnosis of right renal actinomycosis is remarkable and significant.

**Ætiology and incidence.**—Lesions seemingly identical may be caused by different types of actinomyces. Microscopically, all are branched mycelia, the filaments of which contain rows of granules which are Gram-positive and stain deeply. Regarded from a cultural point of view there are two main types: the anaerobic or, more strictly speaking, the micro aerophilic (Welsh, 1935) and the aerobic. The former is passed on from cattle to man through contaminated water either via the intestinal tract or through the abraded skin. It has been customary to attribute the human form of the disease almost exclusively to the anaerobic variety—*Actinomyces bovis*. However, Pijper (1927), Buchanan (1942) and others found that in South Africa at any rate the aerobic type preponderated slightly over the anaerobic, and its source in human disease is still a matter for speculation. Of the four main aerobic types only *A. Transvaalensis* is invariably acid fast.

Actinomycosis appears not to be so rare as was formerly supposed, especially in cattle raising countries. Gardiner (1935) saw in New South Wales some



forty-six cases in twenty years. Only about a score of kidney cases are on record. The disease is rare in childhood, as Kretschmer (1936), in recording a case pointed out. It is carried to various parts of the body and reproduced there by the coccoid and rod like forms into which the fragile mycelia break up. The well-known "sulphur granules" are globular nests of felted mycelium.

**Pathology**—Proliferation of the tissues and pus formation in varied relative proportions characterize the affected kidney. The gross specimen may resemble a tumour, a carbuncle or even a tuberculous kidney with cavitation. Calcification does not occur. There are dense adhesions between the kidney and its fatty capsule and between the latter and surrounding structures. By suitable staining methods the "granules" of the actinomyces may be discovered sometimes readily, sometimes only after a prolonged search. Perinephric abscess is not uncommon. The ureter may be thickened and strictured. Ulceration, on rare occasions, occurs in the bladder.

**Symptoms and signs**—After an unknown period of resistance, indicated only by the vaguest of symptoms, notably abdominal pain, the patient goes rapidly downhill and consults his doctor on account of lassitude, loss of weight, anorexia, night sweats and evening pyrexia. Anæmia of the secondary type with low colour index is invariable. There is usually a mild leucocytosis.

In the course of two or three months attention is drawn to one or other kidney by the discovery of a mass in the loin with corresponding tenderness and muscular rigidity. Urinary symptoms are variable, and at this stage more commonly absent. There may be a few pus cells in the urine or none. Cocci and bacilli of various kinds have been noted, and in a few cases acid fast bacilli have been seen. The latter may have been the disintegrated mycelial rods previously mentioned, though the combination of tuberculosis and actinomycosis has also occurred.

Recently McCrea and Spalding (1946) have reported the cultivation of aerobic actinomyces from the bladder but not from the kidney urine of 35 female patients. They are inclined to think that these cultures were not due to contamination but were derived from mycelial saprophytes of the urethra which occasionally gave rise to mild and transitory trigonitis.

Cystoscopy often reveals little in a first examination, but the function of the affected kidney deteriorates rapidly. Pyelograms commonly give a picture of spread, elongated or obliterated calyces as in tumours, but the pyonephrotic or even cavitation type also occurs. A strictured and beaded ureter may be present as in tuberculosis. Judged by the customary function tests the other kidney appears to be sound. Bilateral infection is rare, or, at any rate undiagnosable.

**Diagnosis**—A correct diagnosis has rarely been made even at the time of operation. The surgeon and sometimes the pathologist are unaware that an actinomycotic kidney has been removed. The specimen may be considered a neoplasm, a renal carbuncle or a tuberculous kidney. The sinus resulting from the operation shows little tendency to heal, yet meticulous examination of the pus over a period of months may reveal no trace of the actinomyces. Finally, "sulphur granules," which, incidentally, may be black or brown as well as yellow, indicate the true nature of the disease. Revision of the specimen confirms the diagnosis.

The general symptoms are a combination of those of tumour plus infection. Hæmaturia is rarer than in tumour cases, and the loss of function is greater in actinomycosis. On the other hand, severe urinary symptoms are more characteristic of tuberculosis. The absence of colonies of actinomyces in the urine is the rule. No satisfactory complement-fixation test has yet been devised.

**Prognosis**—Nephrectomy combined with vigorous after treatment has resulted in some apparent cures but on the whole the outlook is bad. Apart from the operative mortality, considerable in itself many of the reported cases died from generalized actinomycosis pyæmia or debility resulting from the persistent suppuration. Renal failure through subsequent involvement of the other kidney has not been recorded.

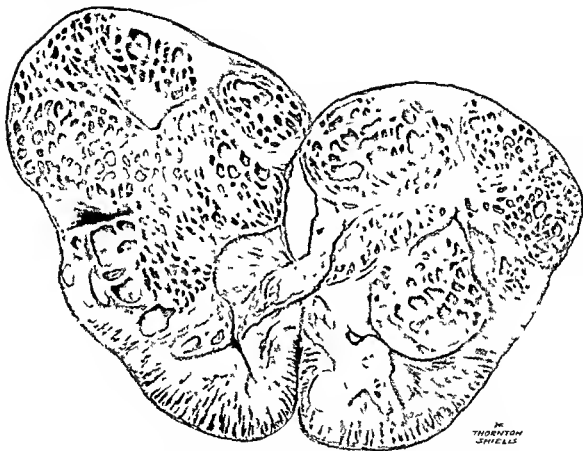


FIG 407

A sectioned right kidney removed post mortem from a man aged 43 who died as a result of infection from the streptothrix actinomyces (From the Museum of the Bland Sutton Institute of Pathology the Middlesex Hospital)

**Treatment**—In suitable cases nephrectomy appears to be indicated possibly in two stages. The operation is a formidable one on account of the widespread adhesions. The low condition of the patients demands pre operative blood transfusions shock sparing methods such as spinal anaesthesia or nerve block, and very careful after-treatment. The wound should not be closed but treated with eusol, chloramine-T, mercurochrome, hydrogen peroxide or pyrogenic filtrate. It should be allowed to heal from the bottom. The value of radium has not been established.

As soon as the operation is over or before it is undertaken in those rare cases in which pre-operative diagnosis is possible, the general treatment for actinomycosis should be undertaken. The remedies which have proved valuable, singly or in combination, are the sulpha drugs and iodine. Four

grammes a day for two days and 2 gm for another three should be administered, and this course repeated with the usual precautions

Iodine in the form of potassium iodide up to 300 or 400 gr a day is the traditional treatment but Chitty (1929), a score of years ago recorded some remarkable results by giving 10 minims of tincture of iodine in milk or cream four times a day Sodium iodide in 10 per cent solution has been given intravenously

Various forms of X ray treatment have as a rule been combined with the drugs mentioned Thymol has also been recommended

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## CHAPTER LXXVII

### SYPHILIS OF THE GENITO-URINARY ORGANS

**SYPHILIS** is a specific disease due to entry into the body of a microorganism (*Spirochæta pallida* or *Treponema pallidum*). In syphilis acquired by infection of the skin or mucous membrane a primary sore commonly develops at each site of inoculation and is followed after a few weeks by the first of a succession of outbreaks on skin and mucous membranes and of other lesions which may affect any tissue of the body. These may recur again and again throughout life and those which appear in later years seriously damage the function of the parts affected. After many years degeneration of the parenchyma of the nervous system may lead to general paresis or to tabes dorsalis. From an early stage changes in the blood serum can be detected by complement fixation (Wassermann) and various flocculation tests. In a number of cases also certain well defined changes in the cerebrospinal fluid occur within a few weeks of the first appearance of external signs. In syphilis acquired by transfusion or *in utero* the systemic disease is the first manifestation. Any or all of the external signs of the disease including the primary sore may be omitted and even the characteristic changes in the blood may never appear.

Of the above manifestations only those affecting the genito urinary organs can be considered in any detail in this chapter but it is necessary to discuss the bacteriology and morbid anatomy of the disease as a whole sufficiently to enable the reader to understand its symptomatology and to avail himself properly of laboratory aids to diagnosis.

#### BACTERIOLOGY

The micro organism of syphilis discovered by Schaudinn and Hoffmann (1905) was first named *Spirochæta pallida* and later *Treponema pallidum*. To day it is known by either name and will be referred to in this chapter as *S. pallida*.

When discharge from an early syphilitic lesion is examined under dark ground illumination the method of choice *S. pallida* appears as a dead white delicate mobile corkscrew with very regular coils 10 to 12  $\mu$  deep and from crest to crest 4 to 24  $\mu$  (usually 7 to 10  $\mu$ ) long and 0.25  $\mu$  thick. It moves across the field rather slowly but is very active and flexible in its own ground.

It can be examined in the dried state after mixing some of the discharge with an equal quantity of indin ink or of collargol and spreading the mixture as a film on a slide. It then appears as a white spiral rather thicker than under dark ground illumination and by no means so easily distinguished from other spirochætes. It is dyed rose pink by prolonged staining with Giemsa or Leishman stain and is easily stained by the silver nitrate method of Tribondeau.

It is indistinguishable morphologically from *S. pertenue* of yaws and from *S. cuniculi* of a superficial affection of the external genital organs of rabbits.

Various claims to cultivate *S. pallida* have been made but considerable doubt of their validity has been expressed by Kast and Kolmer (1929) and others recently however P. Grigorev (1939) has published a claim to have cultivated it from the blood of persons suffering from primary syphilis and to have transmitted the disease to animals by cultures thus obtained. As here there was no question of contamination with saprophytic spirochaetes and as the organisms proved virulent for animals the claim merits serious attention.

**Vitality and virulence**—In discharges removed from the body *S. pallida* loses its virulence in a few hours but in the moist state in a capillary tube or sealed between slide and cover slip I have known it to retain its motility for as long as eighty four days. It is killed at once by drying and by relatively weak antiseptics. According to Boak, Carpenter and Warren (1932) its virulence is destroyed in an hour at 41.5° C. according to Bessemans (1938) it is killed in lesions of rabbits in one hour at 42° C. and in two hours at 40° C. but in lymph nodes of the same animals it may remain virulent for one hour at 46° C. Its susceptibility to heat is exploited in treatment.

### PATHOLOGY

It is doubtful if the organism can penetrate unbroken skin but it can of course enter the body through a microscopic crack. After admission it quickly penetrates to the deeper tissues. Syphilis is believed generally to have been prevented by Metchnikoff and Roux (1906) in a medical student and a chimpanzee by rubbing calomel ointment into the site of an experimental inoculation one hour after the latter. But later experiments suggest that the student may have been fortunate if he did escape (the proof of the escape would not be accepted by modern experimenters) as Kolle and Ivers (1926) showed that after inoculation of rabbits the organism can reach the nearest lymph glands within half an hour. The micro organism is widespread throughout the body within forty eight hours but the first lesion does not appear for several days. The syphilitic process in every stage except the quaternary (see below) consists essentially of accumulations of lymphocytes and plasma cells chiefly round lymph and blood vessels with an increase of connective tissue and mast cells and swelling of the endothelium of the small blood vessels of the affected part so that they become narrowed or blocked in many places. The cellular infiltrates which vary in size and intensity with the position of the lesion and the age of the infection account for the toughness which characterizes most syphilitic lesions. Endarteritis causes degeneration of the lesion in its centre and when it affects vessels supplying vital structures it causes degenerations due to lack of nutrition e.g. aneurysm from effects on *vasa vasorum*, myocardial degeneration from obstruction of coronary vessels and paralysis from closure of cerebral and spinal vessels.

Important immunological reactions result in resistance to superinfection and to re infection after supposed eradication of the original infection. Resistance to re infection increases with age of the infection and judging by animal experiments may be permanent after the infection has been active for three months. The development of allergy to activity of *S. pallida* probably explains the larger size of lesions of later stages of syphilis than that of earlier ones in spite of the fact that the number of spirochaetes at work in a late lesion is far smaller than in an early one.

Another manifestation of immunity of great diagnostic value is in blood changes demonstrated by complement fixation (Wassermann) and floccula

tions reactions the latter of which usually depend on the formation of floccules when inactivated syphilitic serum is put in contact with a specially prepared heart extract. Many methods of performing the complement fixation test for syphilis have been evolved and all are designated Wassermann though none conforms to the technique of the original method consequently there is a wide difference in their sensitivity some being too apt to give false positives and some giving only low percentages of positive reactions in the different stages of syphilis. As regards the flocculation tests although their principle is the same in all there are very many methods of demonstrating the flocculation each under the name of its author the best known and probably the most sensitive yet reliable one in this country being the Kahn. Generally speaking the flocculation tests are more sensitive than the complement fixation but in equally good hands the flocculation tests would be more apt to give false positive reactions on the other hand some sera are positive to a complement fixation test but negative to a flocculation and the usual practice now is to test the serum by both methods.

In syphilis the serum becomes positive to one or both these methods by the tenth to fourteenth day after the appearance of the first outward lesion in the majority of cases and by the end of about a month the percentage with positive serum is practically 100. In the absence of treatment the percentage tends to decline slightly in later years but a strong feature of reactions discovered after many years is their persistence in spite of all treatment. Whether this persistence signifies persistence of the infection throughout is unknown but it is possible that such an amount of treatment as would suffice to eradicate an early infection may be sufficient for an old one and that the reaction persists because of a tissue habit. This is at least suggested by the fact that in cases cured of general paresis by pyrexia maintained over only a short period the reactions may not change to normal until as long as three years later. Similarly in cases apparently cured by what is now known as the five day method the blood reactions of the secondary cases persist much longer than do those of the sero positive primary cases.

The reliability of these serum tests for diagnostic purposes depends naturally on their failure to give positive reactions in non syphilitic conditions. Unfortunately no method is completely reliable from this point of view but the conditions in which positive reactions are apt to occur are fairly well defined. They are *yaws*, *trypanosomiasis*, *relapsing fever*, *leprosy*, chiefly *tuberculous malaria*, *scarlet fever*, *typhus fever*, *glandular fever*, *vaccinia*, a transient *broncho pneumonia* with streaky infiltration of the lung (Fanconi (1936) Hegglin and Grumbach (1941) Jahnke (1941)) and some *streptococcal* conditions. Some such as *enteric fever*, *late tuberculosis*, *tropical ulcer*, *beri beri*, *diabetes* and *scleroderma* which have been reported by one author or another to have given positive reactions may have been in a type of patient with a natural tendency to positivity so that they give positive reactions as a result of any biological disturbance such as is brought about by an intercurrent fever. Certain dermatoses such as *psoriasis*, *urticaria*, *pigmentosa* and *erythema* *iris* seem to make the serum more labile in this way though with a reliable test they may not give a false positive. Pregnant sera are apt to give positive reactions with methods which though they may give negative reactions with normal sera are too sensitive for specimens from persons in non syphilitic pathological states.

Apart from these conditions others not at all well defined and not producing any obvious symptoms must be admitted as giving rise to what have been termed *problem sera* since they give positive reactions to all tests

though there is no history or evidence of either syphilis or any of the conditions enumerated above. Although they are undoubtedly rare the possibility of their occurrence compels the advice that when the serum reactions are completely unsupported by other evidence the diagnosis should remain open treatment being withheld over a period of months during which further tests should be carried out.

With the above qualifications provided that laboratory errors have been excluded by a repetition of the tests on a fresh specimen and that the different tests agree positive reactions of a serum mean that the donor has syphilis, they do not of course mean that the lesion from which he is now suffering is necessarily syphilitic unless there is definite evidence that the serum reactions have changed from negative to positive since the present lesion made its appearance.

### SYMPTOMATOLOGY

The signs of syphilis are empirically classified under the headings of primary, secondary, tertiary and quaternary. The first comprises the lesions which appear at the site or sites of inoculation and the accompanying regional adenopathy, the second the commonly widespread ones which begin to appear about a month after the first appearance of the primary sore, the third the scanty but usually larger and more destructive lesions which occur after a period of quiescence following the secondary stage and the quaternary the degenerative changes in the central nervous system called tabes, general paresis and tabo paresis. Although empirical the classification is useful for purposes of description. As syphilis in respect of many of its manifestations affects many parts of the body and it is often helpful in diagnosis of lesions in one part of the body to look for others elsewhere it seems best to sketch here the general characteristics of the lesions in the first three of these stages before describing the special features of those affecting the genito urinary organs.

**General characteristics of primary lesions.**—The incubation period varies from ten to ninety days or longer and is usually three to four weeks. In my experience the longer periods have usually followed attempts to prevent the infection either by disinfection or by administration of anti syphilitic remedies. At the end of this period there appears at each site of inoculation the hard chancre or primary sore starting as a papule which enlarges to a pink or dull red relatively painless erosion or superficial thick lipped ulcer. Within a few days of the appearance of the chancre the regional glands usually become painlessly enlarged without any tendency to suppurate unless the original sore has become infected with pyogenic organisms. In the majority of cases only one sore appears but of 9 000 male cases analysed by White and Brown (1920) 1 718 had multiple sores of these 834 had 2 and in the balance the number varied between 3 and 49. Women tend more to have multiple sores than do men.

The painlessness which characterizes most primary sores is relative some in tight tissues as on a terminal phalanx or where the part is liable to much movement as at the peno scrotal angle may be quite painful as may also be sores which have become infected with secondary organisms. Painless enlargement of the glands draining the site of a primary sore though not invariable is a valuable early sign the glands on the affected side becoming enlarged and tough without causing any strong feeling of discomfort and without any tendency to suppurate unless the original sore has become infected with pyogenic organisms. In the case of the external genital organs the glands on the side opposite to that of the sore may be affected either

alone or with those on the same side as the sore. Often also the lymphatics (e.g. the dorsal lymphatics of the penis) become hardened and easily palpable.

*S. pallida* can be found almost invariably in the juice from a primary syphilitic sore from the first hour of its appearance provided that no antiseptic has been applied. The sore is unresponsive to antiseptic applications and also to sulphonamide treatment, the latter characteristic is a useful diagnostic sign as most genital sores other than syphilitic respond to this form of treatment, which does not moreover, interfere with the finding of spirochaetes.

**Secondary lesions**—The first secondary manifestations are usually some enlargement of lymph glands throughout the body and then a pink erythema of the soft palate. This is followed approximately a month or six weeks after the first appearance of the primary sore by a blotchy macular eruption starting on the trunk, especially between a line drawn through the nipples and the angles of the scapulae above and one following the iliac crests and the groin below. The individual spots which may at first be so faint as not to be visible until the skin has been blanched by exposure to the cold for a few minutes, vary in size from a pea to a florin and gradually darken from a rose-pink to a deep red and may then leave brown stains for a number of weeks. Sometimes the spots are slightly urticarial and rarely they become hæmorrhagic or vesicular. In distribution the syphilitic roseola varies greatly. It may be limited to a few spots on the trunk or the limbs so scanty as to be easily overlooked, or it may be widespread so that the spots are thickly strewn over the trunk, the inner sides of the thighs and the flexor surfaces of the arms and legs.

In the absence of treatment the roseola is followed by a succession of papular eruptions which have much the same distribution as the roseola, but occur also on the palms and soles, and the face, especially the forehead (*corona veneris*). The commonest papular eruption on the dry surfaces of the skin is the lenticulo-papular consisting of dome shaped papules varying in size from a lentil to a pea, which are at first light red shiny and well embedded in the skin and scale slightly when squeezed. Later the colour deepens to dark brownish-red, and stains of this rash persist for many weeks after the syphilitic process has been stopped by treatment. Sometimes the papules are very scaly, sometimes they degenerate partly or wholly to pustules forming the papulo pustular and the pustular syphilides, and sometimes they enlarge and become ulcerated and crusted, forming ecthymatous and rupial syphilides.

In moist situations, as on the genitals, between the scrotum or the labia and the thighs, between the buttocks, between the toes under pendulous mammae, and in the mouth and throat, the papules grow into plaques and the loosened epithelium covering them becomes sodden or is rubbed off leaving pink erosions which may be cracked or more ulcerated at the angles of the mouth, on the sides of the tongue and on the tonsils. These lesions are generally known as moist papules when situated outside the mouth and throat and as mucous patches in the latter situation. In many subjects, in the warm moist areas of the body, especially about the genitals the papules grow into grey, broad-based moist warts called broad condylomata. All the papular eruptions just described can almost always be diagnosed with ease and certainty by examination of the serum from them for *S. pallida*.

Another type of papular eruption, which when it does appear is later than the above, is the miliary or the lichenoid. It occurs in two main forms flat or lichenoid elevations, and pointed papules each about the size of a pin head or a millet seed. The latter, which are pale red or brownish are usually



set in small groups or circles in limited areas as on the back or the outer sides of the buttocks. Such groups may be composed of larger papules often appearing as satellites round a central one (corymbose syphilide).

Other secondary manifestations are a patchy or even a general alopecia which is only temporary, changes in pigmentation particularly on the neck which becomes dappled (leucoderma), onychia and paronychia, iritis, epididymitis, disturbances of viscera including hepatitis and nephritis, headache and affections of the central nervous system leading even to cranial nerve palsies and a paraplegia, and more or less constitutional disturbance.

It should be noted that none of the above may occur and that on the other hand a number of them may be present at the same time, this polymorphism of syphilitic manifestations being of some diagnostic value.

Tertiary lesions are generally limited in number and are individually larger than secondary, they tend more to ulcerate and are generally more destructive of the function of the affected part.

The commonest tertiary lesion is the tubero serpiginous or nodular cutaneous syphilide which occurs as a group of small gummatæ about the size of a bean or larger in the skin arranged more or less concentrically round a central nodule. The lesion spreads by the laying down of more nodules disposed in arcs or circles which have for centres the nodules of the first and succeeding sets from which they are separated by narrow zones of normal skin. The result is that the edge of the whole lesion is more or less circular or serpiginous. The nodules may break down to ulcers and the growing edge of the lesion may be a trough but more often there is merely some crusting and the nodules disappear leaving small scars which in their characteristic distribution or pattern remain as a valuable sign of the nature of the process which has occurred on the site.

Single gummatæ of larger size and diffuse gummatous infiltration may affect any tissue of the body and a favourite site is the testicles. Further consideration of this stage may be deferred to tertiary lesions of the genital organs below.

### SYPHILITIC LESIONS OF THE GENITO-URINARY ORGANS

It seems convenient here to describe first the commoner lesions of the different stages and then their differential diagnosis as they occur in the different areas of the genito urinary organs.

**Chancres on the male genital organs**—The commonest site of a chancre in a man is the coronal sulcus where the sore appears first as a dull red or a pink spot about the size of a small pea which quickly enlarges within a few days to the size of a silver threepence, a sixpence or something larger than this. It soon becomes eroded and forms a shallow ulcer with rounded edges raised above the surrounding tissues. These are infiltrated and the whole lesion is matted together into a plaque or button of which the part situated in the preputial tissues lies over like a plate turning on its edge whenever the prepuce is retracted. Secondary infection especially under a tight prepuce may lead to all degrees of ulceration even to phagedæna.

On the dorsum of the glans penis the syphilitic chancre is usually a pink or dark red thin disc which feels like parchment owing to its being so shallow. It is often covered with a thin whitish pellicle.

On the site of the frenum the sore may be fiddle shaped, if the frenum has not broken it is considerably thickened and the neighbouring tissues are tough.

At the urinary meatus the sore may surround the meatus or may spread slightly on to the glans on one side only, most of the sore occupying one wall of the fossa navicularis. In this case the affected wall feels like a thin plate. Intra urethral chancres beyond the neck of the fossa are not often diagnosed, the only one which I ever saw was a very definite lesion, a crescentic ledge at the peno scrotal angle. The urethroscopic examination was prompted by finding *S. pallida* in a scanty serous urethral discharge which had been diagnosed on clinical grounds as gonococcal. It seems probable that if all such discharges appearing several days after a sexual risk were examined for *S. pallida* the discovery of intra urethral chancres would be much commoner than it is at present.

In the mucous membrane lining the preputial sac the primary sore may be like that in the coronal sulcus or it may be like a cartilaginous disc let into the submucous tissue. Such sores can easily be palpated through the skin of the prepuce, induration in this part being particularly well marked.

On the skin of the external genital organs the primary sore is usually about the size of a sixpence or larger and covered with a brown crust, removal of which discloses dull red granulations level with the surrounding skin. The part of the penis peripheral to the sore may be swollen, tough and somewhat livid with a light scaling, the condition being known as syphilitic indurative oedema.

**Chancres on the female genital organs.**—The commonest sites of such chancres are the labia clitoris, mouth of the urethra, posterior commissure, remains of the hymen and the portio uteri. On a labium majus and at the angle between it and the corresponding labium minus the appearance may be similar to that of a sore in the coronal sulcus, but on the skin of the labium the chancre is commonly like one on the general skin. It is more apt than in the male to be accompanied by syphilitic indurative oedema of the labium. This condition may affect both labia and may also arise from a chancre of either of the labia minora.

On the mucous surfaces at the introitus the appearances are somewhat similar to those of chancres on the mucous surface of the prepuce or on the glans penis, namely flat or slightly cupped, dark red, tough, sharply defined erosions. At the posterior commissure the sore tends to spread to the tissues on both sides of the middle line and is more apt than other chancres in this region to become ulcerated. On the cervix uteri the appearances vary greatly from a sharply defined oval round or kidney shaped erosion on one lip to an ill defined ulcerated mass suggesting a carcinoma. Induration may be perceptible by palpation and be as well defined as in more accessible chancres and the whole cervix may be involved in an indurative oedema when it becomes greatly enlarged and livid.

The site of the glandular enlargement depends naturally on that of the sore, when beyond the area drained by the lymphatics running to the inguinal glands the enlargement affects the pelvic glands and may be perceived by palpation of these through the lateral wall of the vagina against the ischial spine.

**Secondary lesions of the genito-urinary organs.**—These may occur on any part of the external genital organs or on the cervix uteri and in the vaginal fornices and are apt to be mistaken for primary lesions. Thus on the glans penis a few moist papules may be mistaken for primary sores and on the os uteri an erosion in the discharge from which *S. pallida* is demonstrated may on this account be diagnosed as a syphilitic chancre. The most important and frequent secondary lesions of the genital organs are moist papules

and broad condylomata. The former as seen on the ventral surface of the penis the scrotum and the labia majora are moist slightly raised circles each about the size of a silver threepenny bit with slightly depressed centres. The broad condylomata are flat moist warts on the scrotum or the labia the adjoining inner sides of the thigh and often also the contiguous surfaces of the buttocks.

Secondary lesions occur in the epididymis as small nodules in the head. They are said to be very uncommon in this situation but may often be overlooked. In contrast with tertiary syphilis of the epididymis they usually occur on both sides.

In the bladder secondary lesions have been described as macules and ulcers occurring during the eruptive stage of the disease. The condition may be commoner than is supposed as it gives rise to only slight symptoms which are not usually apt to provoke a cystoscopic examination.

Secondary syphilitic prostatitis has been described as occurring very rarely the diagnosis seems to have rested mainly on the association of prostatic symptoms with secondary manifestations in other parts of the body.

Nephritis occurring in the earlier stages of syphilis is usually of the type of large white kidney from which it differs in its great amenability to specific treatment.

**Tertiary lesions of the genito-urinary organs.**—Since no part of the body is immune from syphilitic infection it is not surprising that tertiary lesions either as discrete gummata tending to ulceration or as diffuse infiltration have been described in every component of the genito urinary system male and female and the possibility of this being the cause of indolent swellings in the corpora cavernosa seminal vesicles prostate vasa deferentia walls of the vagina uterus ovaries Fallopian tubes or the kidneys must always be kept in mind but by far the most important and frequent are such lesions affecting the testicles and the end of the penis. In the latter situation the pseudo chancre redux which is often diagnosed as a primary chancre commonly appears as an indurated ulcer on the coronal sulcus or in the preputial mucous membrane and less commonly elsewhere in this area. It seems possible that the indifferent showing of sero positive primary syphilis in statistics relating to results of treatment may be due to the inclusion in this category of a certain proportion of cases of chancreform gumma which like other tertiary lesions may respond well clinically to antisymphilitic treatment but proves very resistant serologically. The distinction is made by the history of an earlier primary lesion by failure to find *S. pallida* in the juice of the lesion and by the absence of any indolent enlargement of regional glands.

Syphilitic orchitis occurs as discrete gummata in one or both testes as diffuse infiltration or most commonly in both these forms. Diffuse infiltration often becomes apparent before the discrete gumma. The testicle becomes evenly enlarged smooth and heavy and pressure on it elicits none of the usual testicular pain. It is commonly painless but may be distinctly uncomfortable so that the latter characteristic should not suffice for exclusion of syphilitic orchitis in diagnosis. Discrete gummata are usually multiple and project from the surface of the testicle like elastic bosses. They usually grow to a maximum and then retrogress but may undergo softening become adherent in the skin and burst leaving a crater like ulcer. The condition is often associated with hydrocele of the tunica vaginalis which may have to be tapped before the state of the testicle can be appreciated.

**Differential diagnosis of syphilitic lesions of the genito-urinary organs.**—Since open syphilitic lesions on the skin and mucous membranes of the

external genitalis may be atypical and resemble non-syphilitic ones and vice versa, it should be accepted as axiomatic that every lesion in this area in which the surface is broken should be scraped and the resulting exudate examined for *S. pallida*, and it may be convenient to describe here methods of taking specimens for this examination, as help in diagnosis may be afforded by examination of other parts of the body the description will not be confined to the taking of specimens from the genital area. From a sore on the genital or other area the specimen is best obtained by first cleansing with a swab wrung out in saline or boiled water and then scraping the margin in such a way as to cause serum to ooze from it. The oozing is helped by squeezing the lesion, and the aim should be to collect a specimen which consists mostly of serum. Condylomata and moist papules may be dealt with on similar lines, lesions in the mouth should be freed as much as possible from saliva by swabbing, and a convenient instrument to use immediately after the swabbing is a small ring curette which acts as a scraper as well as a collector of the specimen. From an ordinary papule on the skin the specimen is best obtained by scraping off the superficial epithelium and then applying suction, this can most easily be done by smearing the mouth of a test tube with vaseline, heating its blind end and then applying the test tube so that its mouth circumscribes the scraped papule in such a way as to dry-cup it. If a sore has been dressed with antiseptics it may be better to take the specimen from an enlarged regional gland if one is available. The gland is pushed up against the skin and fixed there with the fingers of one hand. Then a moderately stout hollow needle, about 18 gauge, is run into the body of the gland from its outer pole. A syringe containing a few minims of sterile saline is fitted to the needle, the saline is injected into the gland which is then massaged and suction is then applied with the syringe as the needle is withdrawn. Probably only enough fluid to fill the needle and the bottom of the syringe will be obtained, and this should be ejected on to a glass slide or into a watch-glass to be collected as shown below.

If the specimen has to be sent to a laboratory it is best to collect it in a capillary tube. One end of a short length of this (say about 4 in.) is applied to the drop of exudate, which will run into the tube. When an inch or so has run in the tube is sealed as follows. The end of the tube farthest from the port of entry is warmed in a flame whilst the finger and thumb cover the specimen to protect it, and that end is then sealed in the flame. When the sealed end cools down the specimen is drawn into the tube leaving a gap between it and the port of entry. This end need not be sealed.

At the same time a specimen of the blood should be taken for examination by the Wassermann and a reliable flocculation test. The technique of obtaining such a specimen is that for venepuncture described on p. 845. Care should be taken to avoid bringing the blood into contact with spirit or with distilled water in the collecting syringe, which should always be well washed out with sterile saline before the specimen is taken.

Negative reactions of blood tests may be due to absence of syphilis, or to the disease not having progressed sufficiently to evoke the necessary antibody response. Positive reactions, if not due to any error in technique or to one of the conditions mentioned on p. 835, are due to syphilis, which may however have been acquired long before the appearance of the present lesion. Other laboratory tests which may be applied in the absence of positive evidence of syphilis are microscopic examination of the exudate for Dancery's bacillus and for Donovan's bodies, and a complement fixation test for lymphogranuloma inguinale.

**GROSS DIAGNOSTIC FEATURES**—Primary syphilitic lesions can usually be distinguished from all others by the rubbery induration of their edges, their comparative painlessness the fact that as a rule—and certainly not after the first fortnight—they are not succeeded by similar lesions and the painless enlargement of satellite glands. Tertiary lesions are usually more tumour-like and unaccompanied by enlargement of regional glands, also *S pallida* cannot be found in the exudate produced by scraping them. Secondary lesions on the genital area if in the form of moist papules may be mistaken for primary, but are usually smaller and more numerous and may have been preceded by a primary lesion also in such cases similar lesions are likely to be present elsewhere on the body. Altogether it is not usually difficult to distinguish the lesions of the different stages of syphilis found on the external genitalia from one another if it is remembered that not all such lesions are primary chancres. Nevertheless tertiary lesions are not uncommonly diagnosed as primary, and as mentioned, this may account for the bad reputation of sero-positive primary syphilis for serological intractability.

The chief non syphilitic lesions from which syphilitic chancres are to be distinguished are chancroid, herpetic vesicles, balanitis, granuloma venereum, the primary lesion of lymphogranuloma inguinale, scabies, molluscum contagiosum, inflammation of Tyson's glands, snellings due to gonorrhœa, and malignant disease.

*Chancroidal ulcers* are more painful and have thinner, more irregular and often undermined edges. They are often succeeded by similar lesions in the vicinity. The streptobacillus of Dugrooy may be found in the juice from the edges. The incubation period is only a few days and any glandular enlargement consequent on chancroid is painful and tends to abscess formation. It is, of course, necessary to remember that a chancroid may have incubating in it a syphilitic chancre, in this case in due course its edges will thicken and the lesion become somewhat similar to a syphilitic lesion.

*Herpetic vesicles* usually occur in crops of pinhead vesicles, but when these break down to form a composite ulcer this may arouse suspicion of its being syphilitic. In my own experience as director of a clinic and a consultant, most mistakes which I have seen here have been in diagnosing as herpetic lesions what proved to be early syphilitic chancres. The mistake is, of course, easily avoided by strict adherence to the rule of scraping every genital lesion and examining the juice of it for *S. pallida*.

*Balanitis* is easily distinguished from chancre by being more diffuse, but the mistake may be made of overlooking a discrete lesion in what appears to be a generally inflamed glans and preputial sac.

*Granuloma venereum* is very uncommon in this country. It has no surrounding induration and the edge is usually overhanging. Often, also there are satellite lesions in the neighbourhood, and Donovan bodies can be found by microscopic examination of the discharge.

The primary lesion of *lymphogranuloma inguinale* is a very evanescent papule, and the glandular enlargement which commonly follows it, though indolent, tends to break down and form fistulæ, differing in this respect from syphilitic adenopathy which does not break down, and from the bubo of chancre which tends to form a single abscess rather than a number of small ones.

*Scabetic runs* on an uncovered glans penis are dry and smaller than chancres. Also they do not grow in size and are usually accompanied by similar lesions elsewhere. They are, in fact, quite unlike syphilitic chancres but the tendency is to think that almost any lesion on the genitalia must be either a chancre or a chancroid.

*Molluscum contagiosum* spots are pearly hemispherical umbilicated nodules from the centres of which white matter can be squeezed

A swollen Tyson gland may simulate an uneroded syphilitic sclerosis but it is cystic and puncture releases pus Sometimes a gonorrhœal lymphangitis causes a swelling at the reflection of the prepuce from the coronal sulcus and by its toughness may suggest a syphilitic lesion but the process is more acute than in syphilis

*Epithelioma* of any part of the external genitalia might at first resemble a primary sore in being hard but it develops more slowly the base of the ulcer is more rugged and satellite glands enlarge much more slowly

The chief non syphilitic lesions affecting this area which might be mistaken for secondary syphilides are *lichen ruber planus* *psoriasis* and *pemphigus vegetans* The two former are much drier than are secondary lesions in these parts and are usually accompanied by similar lesions elsewhere on the body Lichen affecting the glans penis or this and the body of the penis is made up of dry polygonal flat papules which are brownish or violaceous in colour They show no tendency to erosion Psoriasis affecting the glans should cause no trouble if it is remembered that a lesion on the genital area is not necessarily venereal

Broad condylomata in the genital area might be confused with the rather similar outgrowths of *pemphigus vegetans* but these are preceded by bullæ and the condition is generally widespread over the body whereas syphilitic condylomata are usually confined to what might be termed the moist warm areas

Syphilitic epididymitis should cause no difficulty when it occurs as it is usually associated with other signs elsewhere It is far less acute than epididymitis due to the gonococcus and shows no tendency to fistulation as does tuberculous disease of the epididymis

Gummatous orchitis has to be distinguished from tuberculous disease and from malignant disease It is much less painful than tuberculous disease and shows far less tendency to break down Also it affects the testicle rather than the epididymis

Malignant disease of the testicle presents itself in such diverse forms that the distinction should be made rather on the difference from the classical smooth heavy embossed and insensitive characteristics of gummatous orchitis

### THE TREATMENT OF SYPHILIS

The principal remedies used for the treatment of syphilis are penicillin and compounds of arsenic bismuth mercury and iodine all of which are sometimes assisted by artificially induced pyrexia Amongst anti syphilitic remedies the position of penicillin is not yet settled and it seems convenient here to describe first the use of the older remedies and then to discuss penicillin with the question how far present day knowledge of its action justifies its substitution for arsenic bismuth and mercury

**Arsenical compounds**.—These are in two classes pentavalent and trivalent of which the latter are by far the most frequently used for syphilis outside the central nervous system of adults The pentavalent compounds apart from their role in the treatment of syphilis of the central nervous system have been found convenient for the treatment of congenital syphilis when it is judged undesirable to give injections

All the trivalent compounds except one are subject to the provisions of the Therapeutic Substances Act, which provides for their biological testing

before issue to the public. Those which are subject to this control are (i) 3 to 3-diamino-4 to 4-dihydroxyarsenobenzene dihydrochloride, or the original '606, which first appeared on the market under the trade name, salvarsan and is now sold under a number of trade names but is officially known as "arsphenamine"—a name which must appear on every ampoule of it whatever the trade name. It is the most efficient of these preparations, but on account of the complexity of its preparation for injection and of its administration is no longer used in this country, it will therefore not be considered further.

(ii) The sodium salt of (i) also not now used in this country. (iii) Sodium 3 to 3<sup>1</sup>-diamino 4 to 4<sup>1</sup>-dihydroxyarsenobenzene mono and di-N-methylene-sulphoxylate the original "914" first sold under the name of neosalvarsan and now under a number of trade names but known officially as neoarsphenamine. (iv) 3 to 3<sup>1</sup>-diamino-4 to 4<sup>1</sup>-dihydroxyarsenobenzene N N N trimethylenedisulphite, known officially as sulpharsphenamine. (v) 3 to 3<sup>1</sup>-diamino 4 to 4<sup>1</sup>-dihydroxyarsenobenzene diglucoside (stabilarsan), known officially as arsphenamine diglucoside. (vi) A silver complex of arsphenamine known as silver arsphenamine. (vii) Neosalvarsphenamine. All the above except the diglucoside are in powder form in ampoules containing a neutral gas to prevent their oxidation to the more toxic arsenoxide.

The last in this group, which is not at present subject to control, but has come greatly into use in the past few years, especially in the U.S.A., is 3-amino-4-hydroxyphenylarsine oxide, which is believed to be chemically identical with the spirochætidal derivative of the arsphenamine compound formed in the body after injection. Weight for weight it is much more toxic than the other preparations mentioned above, but, weight for weight, it is therapeutically more active. The ratios of these two activities to the corresponding ones of the arsphenamine preparations will be discussed below. The only brands of this preparation at present on the market are the hydrochloride which is known as mapharside in this country and as mapharsen in the U.S.A., and the tartrate, which is sold as neo-halarsine. The class will be referred to below as oxophenarsine except in references to specific experiments.

Of the preparations other than oxophenarsine, the most commonly employed in this country are neoarsphenamine, arsphenamine diglucoside (stabilarsan) and sulpharsphenamine. The last of these is much less active than the other two when given intravenously, and is not recommended for use by this route, when given by the intramuscular or deep subcutaneous route for which it is the most suitable preparation, its effect is approximately equal to that of neoarsphenamine.

The silver preparations mentioned above are approximately twice as active as neoarsphenamine and are usually given in about half the dosage.

Oxophenarsine is a stable preparation which is not liable to become more toxic on exposure to air and has been said in some quarters to be more efficient and less toxic than neoarsphenamine. Weight for weight it is of course more toxic, the question of chief importance is whether or not it is less toxic in therapeutically equivalent dosage, and this, of course, depends on what is equivalent dosage. Most of the claims for the effect of the compound are based on cases treated also with bismuth, so that in them it is impossible to say how much of the credit is due to the latter remedy, but a straightforward comparison has been afforded by the results of the pioneer New York trial of the effect of a five day treatment in which an arsphenamine compound was administered by drip feed during ten hours of each day for five days.

In the first series of cases the remedy employed was neoarsphenamine in a total dosage of 4 gm and the results reported eventually by Leifer Chargin and Ilvian indicated that 89 per cent of ninety seven patients treated by this method and observed sufficiently long were cured by it. As the toxic effects of neoarsphenamine administered on these lines were too numerous and severe niapharsen was substituted. The dosage first tried (0.4 gm in five days) was based presumably on the claim that the arsenoxide was ten times as active as neoarsphenamine but it was not until the total dose was raised to 1.2 gm that results at all comparable with the above were obtained and even then they were not so good 82 per cent of ninety nine cases being reported as satisfactory. Animal experiments support the conclusions derived from this comparison.

In fact the weekly dosage of oxophenarsine in routine work (as distinct from modifications of the five day treatment) appears now to be usually 0.1 to 0.12 gm in two or more injections. Whether in this dosage it will prove more efficient and less toxic than neoarsphenamine or the reverse remains to be seen.

For intravenous injection any of the above mentioned remedies except stabilarsan is prepared by solution in from 2 to 10 c.c. sterile distilled water. stabilarsan is ready for injection when withdrawn from the ampoule.

The following hints on preparation of the solution and its intravenous injection may help the unpractised reader to perform what is generally a trivial operation but is nevertheless a cause of anxiety to many practitioners and is often performed very badly even by experienced surgeons.

(a) Except when using oxophenarsine solution should be effected without undue admixture with air as may result from frothing and much turbulence. Whilst it is important that the solution should be complete it should not be strained as this reduces the size of the dose.

(b) A needle of S.W. Gauge 21 or 22 with a short slightly concave point is very good for the purpose. The point should be touched up after each injection by slight rubbing across the long axis of the point on one of the rounded edges of an Arkansas stone or better as described in the Medical Research Council's War Memorandum No. 15 (1945). A properly sharpened point should catch in the thumb nail when pushed along this at a very acute angle.

(c) Good distension of the vein by application of a tourniquet on the upper arm is important. If it does not stand up well it is best to mark the skin with iodine exactly over its course.

(d) The skin distal to the point of puncture should be fixed by the forefinger of the hand not manipulating the syringe.

(e) The needle should be held almost parallel with the skin with the bevel uppermost and should be pressed steadily through the skin into the vein so that on entry of the latter it will travel along its interior not cross to the other side and puncture the opposite wall. The operator should look keenly along the vein and the stroke should be away from the operator's body not across it.

(f) On the vein being punctured the operator pulls on the piston of the syringe to verify by the entry of blood that the needle point is within the vein. The tourniquet may then be loosened or left on. In the latter case the solution enters the circulation more slowly and vasomotor reactions are less apt to occur.

(g) With all preparations except oxophenarsine the injection should be slow. With oxophenarsine it should be rapid to prevent pain in the vein.



(h) Throughout the injection a close watch should be kept for the appearance of any swelling close to the vein indicating escape of the solution into the surrounding tissues. In any case of doubt the operator should try to draw some blood back into the syringe and if it will not come the needle should be withdrawn. On no account should the injection be continued if there is any doubt about the needle being properly within the vein. In the event of some drops of the solution escaping into the surrounding tissues 4 or 5 c.c. sterile normal saline should be injected there to dilute the drug and reduce the irritation.

For the deep subcutaneous injection of sulpharsphenamine the dose should be dissolved in about 2 c.c. distilled water or in one of the anæsthetic solutions sold for the purpose. The injection is made under the fat overlying the gluteal muscles in the upper and outer quadrant of this region. Here a piece of skin and underlying fat is pulled away from the muscle and the needle run in so as to plant the point under the fat. The injection is made slowly and the site well massaged afterwards. When given by this route the drug does not cause muscular pain though the area may afterwards be rather tender to pressure.

For intramuscular injection the needle about  $1\frac{1}{2}$  in. long is plunged into the muscle in a direction at right angles to the surface. It is important not to direct it downwards towards the structures emerging from the great sciatic notch. The base should be inspected to see that no blood is issuing from it and after the syringe has been fitted the piston should be pulled upon to ensure that the point of the needle is still not within any vessel.

**Toxic effects of arsphenamine preparations—LOCAL—**An injected vein may become thrombosed but the result is merely that the vein cannot be used for future injections. The fact that a vein may become thrombosed has to be remembered when it appears unduly stiff before the tourniquet is applied because an attempt to introduce the remedy into it may cause some to be spilt into the surrounding tissues. The latter accident has been mentioned above.

**GENERAL—**These compounds damage capillary endothelium and the parenchyma of the liver. In patients who have died as a result of arsphenamine injections there have been found blockage of cerebral capillaries with small hæmorrhages around them hæmorrhagic nephritis hæmorrhage into lung, alveoli submucous hæmorrhages in the gastro intestinal tract and evidence of degeneration of liver cells. In addition in certain cases there is evidence of severe damage to the skin.

Clinically toxic effects are manifested by one or more of the symptoms set out below. In roughly chronological order they are —

During, or immediately after the injection various vasomotor disturbances urticaria and syncope.

Occurring later on the day of injection rigor and fever with general malaise gastro intestinal disturbances and herpes labialis.

Occurring at various times from a few days to some months afterwards albuminuria stomatitis general debility various dermatoses various blood dyscrasias polyneuritis jaundice severe cerebral symptoms and increase of exfoliative signs and symptoms.

The vasomotor symptoms consist mainly of flushing of the face and possible swelling of the lips and tongue with some respiratory distress. They are prevented by giving the injection very slowly and by injection of 10 to 15 minims of 1 in 1000 solution of adrenalin hydrochloride before the injection. This is a precaution which is only rarely necessary if in susceptible subjects.

the tourniquet is kept on during the injection. Urticaria is often preceded by the vasomotor symptoms just mentioned. Syncope usually amounts only to some feeling of faintness as a prelude to vomiting which is best prevented by the patient having no food for two hours before any intravenous injection. This precaution is unnecessary before an intramuscular or deep subcutaneous injection. More severe cases of syncope usually yield to the remedies commonly employed for this complication.

Feverish reaction is more apt to follow the first injection. It is not usually of any moment but if it becomes more severe with each succeeding injection a reduction of dosage is indicated as it may precede a severe dermatosis. Gastro intestinal disturbance is rarely troublesome but may amount to severe vomiting and diarrhoea. In such cases some impurity in the solution or the fact of its having undergone more than usual oxidation should be suspected.

Albuminuria is more commonly due to the heavy metal than to the arsphenamine preparation. The fact that it may occur is a warning that the urine should be examined periodically. Stomatitis is also more commonly an effect of the heavy metal. General malaise and debility increasing as the course of treatment proceeds are a clear indication to suspend the injections for a period.

Dermatosis share with hepatitis and encephalitis responsibility for almost all the deaths following arsphenamine treatment. The simplest forms are the fixed exanthem and Mihan's ninth day erythema. The most severe is an erythema which develops into an acute exfoliative dermatitis. The fixed exanthem is an eruption of very limited extent which recurs in the same spot after each successive injection. It is not of any serious importance. Mihan's ninth day erythema appears from the seventh to the twelfth day after the start of the treatment and within a day or two of an injection. The rash is preceded by fever to 101° F or higher with corresponding constitutional symptoms for a few days. It is scarlatiniform, rubeoliform or polymorphic and usually fades in a few days with little or no desquamation.

Sometimes patients who have suffered no serious dermatitis develop a few patches of seborrhœic dermatitis and sometimes *heben ruber planus* has supervened but these are rare effects.

**EXFOLIATIVE DERMATITIS**—The type of dermatitis with the most serious possibilities appears to result from sensitization of the skin to arsphenamine preparations. It may appear after only a few injections or one or two months after a long intensive course. Sometimes it is morbilliform and limited to only a small portion of the body but in more severe cases it starts as a more or less generalized scarlatiniform erythema which progresses to an acute exfoliative dermatitis with intense itching, widespread scaling, cracking and weeping of flexures, toxæmia, glazed tongue, high temperature and perhaps some purpura. Such cases are prone to die of broncho pneumonia, toxæmia, intestinal hemorrhage or simple marasmus apparently from failure of the digestive and absorptive functions. Examination of the blood may disclose evidence of a blood dyscrasia and agranulocytosis may account for the fact that in a number of these cases the resistance to septic infection of the skin appears to be low. Boils and abscesses being very common and continuing to complicate convalescence after the desquamative condition has more or less subsided.

**PREVENTION AND TREATMENT OF EXFOLIATIVE DERMATITIS**—Patients who are naturally prone to dermatoses seem to tolerate arsphenamine treatment worse than others and should be watched with particular care. Those with carious teeth should have the condition remedied. Careful attention should

be paid to any sign of irritation of the skin and any patch of erythema developing after an injection is an indication to suspend treatment pending developments. By attention to such rules the severity of any dermatitis which may occur is undoubtedly reduced. Generalized dermatitis requires rest in bed and careful nursing. The diet should be of the simplest form—milk, whey, milky puddings, jam, plenty of sugar and large quantities of bland liquids with halibut oil and some vitamin B preparations are sufficient. Meat of all kinds and their extracts, as also eggs, should be avoided, as I have often seen them aggravate the condition. It is necessary to remember that in these cases there is often serious desquamation of the intestinal epithelium. British Anti-Lewisite (B.A.L.) should be injected in accordance with directions issued with this product.

The thiosulphates have had a great vogue for this condition and in fact for any toxic effect of arsphenamine, but they may have been overvalued. Probably calcium thiosulphate given intravenously in a dose of 0.6 to 0.9 gm. in a 10 per cent solution is more effective than the sodium salt. It is apt to cause generalized tingling over the whole body which though not serious may alarm the patient but the disturbance passes off in a few minutes. The thiosulphate may be given on alternate days and on the days between it is useful to give intravenous injections of 30 to 50 c.c. of 30 per cent glucose.

For local treatment calamine lotion and powder seem to be better than ointments or starch poultices. Occasionally a bran or an oatmeal bath is useful to allay irritation but then great care has to be taken to prevent the patient catching cold.

The question often arises of administering more arsphenamine after recovery. According to published reports the patient has sometimes tolerated an arsphenamine preparation of a kind different from that which caused the first attack but having seen the condition flare up on administration of even a minute dose as long as ten years after recovery from the first attack, my own strong inclination is to eschew arsphenamine preparations in the future treatment of any patient who has at any time suffered from a dermatitis of greater severity than the fixed exanthem or the patch of seborrhœa mentioned above.

**BLOOD DYSCRASIAS** in the form of thrombocytopenia, granulocytopenia and aplastic anaemia occur in serious forms only very rarely. For their management general medical works should be consulted.

**POLYNEURITIS** is a very rare complication but has occurred more frequently in patients treated by recent intensive methods by intravenous drip and multiple injections within a relatively few days.

**JAUNDICE**—Some damage to the liver occurs in a fairly high proportion of cases treated with arsphenamine compounds but it only rarely reaches the degree of acute necrosis (yellow atrophy). In an uncertain proportion it is manifested by jaundice which cannot be distinguished from the jaundice of infective hepatitis. It is extremely rare in private patients and its incidence in clinics varies greatly not merely as compared with one another but with seasons. It is undoubtedly more common in syphilis cases under treatment at times when epidemic or infective jaundice is prevalent and it is generally believed that the arsphenamine is not the only aetiological factor though undoubtedly the prevalence increases with the intensity of the treatment. Indeed recent work by MacCallum (1943) by Salaman *et al.* (1944) and others has practically proved that although the arsphenamines and syphilis itself may be hepatotropic, most of the jaundice encountered in syphilis patients in clinics is due to an agent transmitted from patient to

patient through imperfectly sterilised syringes. It seems possible also that arsphenamine administered to a patient with latent infective hepatitis may aggravate the condition sufficiently to make it manifest as jaundice. For the prevention of jaundice the best practical measures appear to be careful sterilization of syringes between injections and suspension of the treatment on the appearance of urobilinogen in the urine. A simple test for urobilinogen is to add to 5 c.c. of the cold urine two drops of a 2 per cent solution of *p*-dimethylaminobenzaldehyde in 5 per cent hydrochloric acid—a deep red coloration is an indication to stop the arsphenamine treatment for a few weeks continuing with bismuth. Treatment is on general medical lines with very light diet and alkaline stomach sedatives but in severe cases intravenous injections of 30 c.c. of a 30 per cent solution of glucose given daily seem to help. After recovery it is generally possible to resume the arsphenamine treatment but it is necessary to be cautious in this watching carefully for any sign of relapse.

**CEREBRAL SYMPTOMS**—Very rarely and often then from two to five days after the second injection a patient develops a violent headache becomes confused passes into epileptiform convulsions and then usually dies in coma. The autopsy in such cases reveals capillary hæmorrhages in the brain and sometimes hæmorrhagic nephritis. The prognosis is grave but the following procedure has sometimes seemed to be effective—removal of 15 to 20 c.c. of cerebrospinal fluid repeated on subsequent days if necessary and bleeding to 15 to 20 oz. Ransome Paterson and Gupta (1945) have reported brilliant results from lumbar or cisternal puncture full sedation and nursing the patient in the sitting position the last to promote reabsorption of fluid from the cerebral tissues.

**AGGRAVATION OF SYPHILITIC SYMPTOMS** (Jarisch Herxheimer reaction) is not strictly speaking a toxic effect of arsphenamine treatment but is conveniently discussed with these side effects. It lasts usually for less than a day and is of no particular importance except in cases of syphilis of vital structures when it might be dangerous.

**COMPLETE AND PARTIAL CONTRAINDICATIONS TO ARSPHENAMINE TREATMENT**—Complete contraindications are status lymphaticus hæmophilia advanced visceral disease and a history of arsphenamine dermatitis. Partial contraindications calling for very cautious dosage are renal disease syphilitic hepatitis myocarditis aneurysm disease of the central nervous system. Addison's disease diabetes hyperthyroidism blood dyscrasias and non syphilitic dermatoses.

**Pentavalent arsenical remedies**—These are (i) *N* phenylglycineamide *p* arsenate of sodium or tryparsamide (ii) 3 acetyl amino 4 hydroxy phenylarsonic acid or acetarsol which is sold as stovarsol or arsan spirocid and kharophen (iii) the sodium salt of (ii) for injection and (iv) the diethylamine compound of (ii) which is sold as acetylarsan. Of all these tryparsamide is used for the treatment of syphilis of the central nervous system and need not be considered further here. Acetarsol is used largely for the treatment of infants with congenital syphilis and like the remaining two preparations is used only uncommonly for the treatment of acquired syphilis in the adult. Some acetylarsan or the sodium salt of (ii) above can often usefully be injected into a hard primary sore as in these cases there is a danger that arsphenamine preparations circulating in the blood stream may not be able to reach spirochaetes buried in such a sclerosis in sufficient strength to destroy them such surviving remnants are responsible for recurrent chancres.

**Bismuth preparations**—Bismuth, introduced into the treatment of syphilis by Sazerac and Levaditi in 1921, has now largely replaced mercury for the injection method of administration. Weight for weight it may not be quite so effective as mercury, but it can be administered safely in approximately four times the dosage usually employed with mercury, and in this dosage it is more effective. The available preparations are water-soluble, oil-soluble and insoluble of which the first need not be considered further.

THE OIL SOLUBLE PREPARATIONS OF BISMUTH are absorbed rather more quickly than the insoluble and are commonly given twice weekly for this reason as the aim is to keep an effective dose of bismuth in the circulation without overloading the kidneys. The preparations of this class commonly used in this country are (i) basic bismuth carboxethyl-methylnonoate, or bivitol 1 c.c. = 0.035 gm. Bi, bismuth butylthiolaurate, or neocardyl, 1 c.c. = 0.05 gm. Bi, (ii) bismuth dimethylendomethylene-hexahydrobenzoate, or neo oleosal, 1 c.c. = 0.03 gm. Bi, and bismuth-carbethoxycyclo-hexanyl acetate or stabismol, 1 c.c. = 0.1 gm. Bi. An average adult man can usually tolerate the injection of a total of 0.3 to 0.4 gm. bismuth metal weekly provided that the daily amount presented to the kidneys for excretion is not too large. To get this dosage safely into a patient when an oil-soluble preparation is employed usually requires two to three injections a week.

THE INSOLUBLE PREPARATIONS are the most popular because they are not absorbed too rapidly, and the weekly dose can usually be given in one injection. The most commonly employed preparations are, (i) precipitated bismuth in *Injectio bismuthi* (B.P.), and in bisglucol, bismostab, and hypoloid bismuth metal each containing 0.2 gm. Bi per c.c., (ii) bismuth oxychloride, in *Injectio bismuthi oxychloridi* (B.P.), hypoloid bismuth oxychloride and bisoxyl 1 c.c. = 0.08 gm. Bi, and in chlorostab, 1 c.c. = 0.16 gm. Bi, (iii) bismuth salicylate in *Injectio bismuthi salicylatis* (B.P.), bisantol, bismosan, bismogenol 1 c.c. = about 0.06 gm. per c.c., bismuth hydroxide, in spirilan, 1 c.c. = 0.086 gm. Bi, (iv) iodobismuthate of quinine, in biquinyl, bismosalvan quincy, quinostab, rubyl, vijochin, 1 c.c. = approximately 0.02 gm. Bi when the suspension is 10 per cent. Of all these I prefer the oxychloride and reserve the iodobismuthate of quinine for late cases of syphilis.

**ADMINISTRATION OF BISMUTH**—The intravenous route has been discarded, being much too toxic. Some preparations have been made for oral administration, but so far they have not attained any noticeable popularity. Injections of bismuth compounds are ineffective, and there remain the deep subcutaneous and the intramuscular routes (p. 846). There is little to choose between the two but generally the patient is more comfortable after the deep subcutaneous injection because of the absence of pain on movements of hip muscles. Particular care must be taken to prevent injection into a vein, as bismuth preparations can get away into the circulation much more easily than can mercurial, and the result of an embolus is often fatal. The injection should be given slowly, and after it the site should be well massaged with a ball of cotton wool or similar instrument.

**TOXIC EFFECTS OF BISMUTH**—The chief toxic effects of bismuth are on the mouth and the kidneys, but they may sometimes be seen in disturbances of the bowels, in the nervous system and in the skin. As regards the mouth, the first sign is a slaty blue line on the margins of the gums, often first just behind the incisor teeth and seen more commonly next to unsound than to sound teeth. The blue line is inconvenient only because it is a tell tale, and it is not an indication to stop the treatment. At the same time it is a rough

guide to the speed of absorption and if it appears early in a course of treatment a particularly close look out should be kept for signs of irritation of the buccal mucous membrane. These develop in the form of aphthous stomatitis which may go on to cancerum oris if the bismuth treatment is not stopped. This condition I have not yet seen. For treatment of stomatitis see below.

*Albuminuria* is uncommon but its possibility is an indication for periodical testing of the urine.

*Gastro-intestinal disturbance* in the form of pains constipation or diarrhoea is uncommon as also are restlessness insomnia rheumatic pains and general depression of spirits all of which are mentioned only because their relation to bismuth treatment may not be recognized.

*Skin disturbances* of many kinds have been described even exfoliative dermatitis and purpura but the latter are very rare. The commonest is in the form of patches of seborrhoeic dermatitis on various parts of the body. They give no trouble apart from anxiety in the patient's mind and do not usually call for suspension of the treatment.

**Mercury**—Preparations for the injection of mercury need not be considered here as they have been quite superseded by bismuth. Mercury administered by inunction is an effective form of treatment if the preparation mercurial ointment of the B.P. is rubbed in by a skilled attendant. About 2 drachms are rubbed into about a sixth different part of the body skin on six successive days a bath is given on the seventh and the sequence is restarted the following week continuing so for a course of six to ten weeks. Oral administration is useful for old standing cases in which a great number of injections of bismuth and arsenic have been given. It may be a good stand by when for any reason a patient is unable to attend for injections for a few weeks. For the purpose yellow mercurous iodide is better than grey powder or blue pill. It may be given in tablets or pills of  $\frac{1}{2}$  gr increasing from three to eight or nine a day. If it causes gastro intestinal disturbances in doses less than  $\frac{1}{2}$  gr a day it can be combined with 1 gr tablet of Dover's powder given separately in dosage sufficient to control the disturbance.

**TOXIC EFFECTS OF MERCURY**—The chief toxic effects of mercury are stomatitis and nephritis. It may also cause gastro intestinal disturbance various dermatoses general malaise and ulcero gangrenous vaginitis. The possibility of nephritis occurring indicates examination of the urine at short intervals. Under these conditions no serious trouble need be feared from this cause. If the mouth is watched and the treatment stopped when the gums begin to feel sore the stomatitis is soon controlled. If such precautions are neglected the condition may become a very severe ulcerative stomatitis. The prevention and treatment of stomatitis are important as it may interfere unnecessarily with the administration of effective doses of mercury the margin between effective and toxic doses of mercury being very narrow. The teeth should be put in order before or early in the course of the treatment and should be kept clean by the usual methods. If the gums become sore the mercury should be stopped temporarily or the dose reduced according to the severity of the complication. The mouth should be washed out frequently with hydrogen peroxide solution and the gums rubbed with a solution of one of the arsphenamine preparations. The bowels should be kept open with magnesium salts and the patient should suck lozenges containing chlorate of potassium.

**Penicillin**—Since Mahoney Arnold and Harris (1943) demonstrated the value of penicillin in syphilis a very great amount of work has been done in this field. In the U.S.A. particularly very large numbers of patients have

been treated with this remedy on a large variety of plans and it is not easy to summarize the knowledge that is available at the time of writing (October 1947) sufficiently well for present day application

The effect of penicillin in appropriate doses is at least equal to that of the best arsenical compounds and correspondingly its immediate effects on the various manifestations that are susceptible to the action of the arsenical compound are equally dramatic. Penicillin has, of course, the great advantage over the arsenical compounds that for most people, it is practically atoxic, and many times the theoretically effective dose can be given with impunity. A very important therapeutic advantage over the arsenical compounds is that it reaches the *fetus in utero* far more easily, and in the U S A the systematic studies of its effects in preventing foetal infection, or in eliminating this if treatment is started after it has occurred, have shown penicillin to be the most effective agent yet tried. So much so that many eminent medical authorities in the U S A consider that the syphilitic pregnant woman should be treated only with penicillin. Again, in neuro syphilis, although little or no penicillin is detectable in the cerebrospinal fluid after its administration by any other route than the intrathecal, its effect on all forms of neuro syphilis appears to be superior to that of any form of metallotherapy, further, its administration by the intrathecal route appears to offer no advantage over the subcutaneous or the intramuscular. Whether penicillin should be used alone or in conjunction with other anti syphilitic remedies will be discussed below.

ADMINISTRATION AND DOSAGE—Of the different methods of administration, those which require the patient's residence in a hospital or a nursing home for an injection every few hours are quite impracticable for the average syphilitic patient, who will go to great lengths to hide the fact that he is being treated for this disease. For a minority, including pregnant women and patients suffering from syphilis of the nervous and/or the cardiovascular system for whom a cautious start may be advisable, the start may be with three hourly injections of 5,000 to 10,000 units for the first two or three days, but in others it is usually sufficient to give a single daily injection of 600,000 units for ten days in conjunction with arsenic and bismuth, as will be shown later. It is not yet known whether it is necessary for the penicillin to be present in the blood in detectable amounts continuously throughout this period or whether it is sufficient for it to be there for approximately half the time. Certainly the investigations of Lloyd Jones *et al* suggest that the latter is sufficient, and they recommended daily doses of penicillin in solution. On the other hand, it seems safer to administer the single injection in a form that is likely to delay absorption, and of the various preparations for this purpose, the most effective at the moment appears to be the suspension of 300,000 units per c c of arachis oil containing 4.8 per cent of beeswax, according to the formula of Romansky and Rittman (1945). This suspension is very viscid and, before administration, should be warmed to 50° C for several minutes. For its extraction and for injection, I use needles of No. 17 S W G, a separate needle being used for each purpose. Both syringe and needles should be quite dry and the syringe should be well warmed before it is filled—I leave it on the top of the sterilizer until the needle has been inserted. It is convenient to have the patient lying prone because if there is any hitch through the needle becoming blocked, the administration is not complicated by restlessness on the part of the patient. It is advisable to have at hand a sterile wire to push through the needle *in situ* if it does become blocked. It seems possible that before this book is published, improved methods of making the Romansky Rittman or other absorption delaying suspensions may have

resulted in a less viscid preparation and the abolition of the minor difficulties of administration discussed above. Thus Brindle, Fairbrother and Jackson (1947) have shown that the beeswax in the above mixture does not delay absorption more than occurs when arachis oil alone is used, but that it helps to make the suspension more homogeneous than when oil alone is used. For the purpose of ensuring better diffusibility of the penicillin in the mixture 1 per cent of wax was found to be sufficient and with this strength using a practically pure sodium penicillin a suspension of 300 000 units per ml was prepared which could be given through a relatively fine needle without previous heating. The suspension had given satisfactory results in clinical trials and at the time of writing seems likely to oust the more viscid preparations.

**SIDE EFFECTS OF PENICILLIN**—Of all the side effects of penicillin which have been published only three need be mentioned here: they are The Herxheimer reaction, a possible oxytocic effect, and urticaria.

The Herxheimer reaction calls for caution over initial dosage in syphilis of the cardiovascular and the nervous systems and in severe congenital syphilis. The oxytocic effect is disputed by many workers but its possibility and the fact that there is no particular advantage (other than the convenience of getting the course over more quickly) in starting the treatment with a heavy dosage suggest the desirability in pregnancy of keeping the dosage low for the first two or three days as indicated above. If urticaria occurs benadryl (P. D. & Co.) 50 mg. thrice daily is very helpful; it should not be given with any hypnotic.

**Iodine**—The exact mode of action of iodine in syphilis is unknown, but it is agreed that it is valuable in all stages and particularly so in the later ones for the dispersal of the granulomatous collections which are a stronger feature then than in the earlier stages. Of the many preparations which have been advocated potassium iodide is generally agreed to be the best for routine work. A dose of 10 gr. three times a day is usually sufficient and it can conveniently be prescribed in a solution of 1 oz. of the salt to 1 oz. of distilled water. Counting one drop as 1 gr. admittedly not quite accurate, the dose is dropped into half a tumbler of milk or water.

**The use of the above remedies for the prevention and treatment of syphilis**—**PREVENTION**—The experiments of Kolle and Evers (1926) suggest that the spirochæte of syphilis can be out of reach of any antiseptic applied to the surface in less than half an hour; it follows that every minute's interval between exposure and the application of prophylactic measures diminishes the probability of the latter's success. A good condom is the best preventive, but it does not of course protect parts not covered. Also care must be taken in removing a condom to prevent any of the secretion covering its exterior from contaminating the person's skin. Parts not covered by the condom should be disinfected in the same way as are all parts when a condom is not worn. Indeed a good precaution when a condom is worn is to smear the peno scrotal angle particularly well with 33 per cent calomel ointment before the intercourse. The simplest toilet after intercourse is to wash hands and then the parts with soap and water, soak well with a 1 in 2 000 solution of mercury and potassium iodide and then rub in the calomel ointment mentioned above.

The question of administration of anti-syphilitic agents such as penicillin or an arachis preparation is often raised. I have always advised strongly against such a course as it may prevent the development of the chancre, but not the infection which may remain latent for a long time and leave everyone in a fool's paradise. After the disinfectant precautions mentioned above it is advisable to have the blood tested at intervals for not less than three months.



**TREATMENT**—*In early syphilis* a question which has aroused much discussion is whether or not to rely only on penicillin. The question seems to be answered by the facts that (a) the best forms of purely penicillin treatment have been followed by relapses in about 15 per cent of cases (b) the use of metallo therapy concurrently with penicillin has afforded significantly better results than has either form of treatment alone in the same doses (c) treatment by penicillin is still in its infancy and the attack in syphilis is high so that a hedge is indicated.

For these reasons I adhere to my view expressed when penicillin treatment began to be used in the treatment centres in England and Wales that a course of penicillin should be supplemented by treatment with arsenic and bismuth but that in view of the high success of a course consisting of ten injections of neoarsphenamine concurrently with the same number of bismuth it seems justifiable to suspend treatment after giving one such course if a course of penicillin has also been given and the serum reactions are now negative the course to be pursued if they remain positive is discussed below. This is in substitution for the minimum of four courses of arsenic and bismuth which in conformity with the recommendations of the League of Nations Committee of Experts on Syphilis etc I advocated before we had the help of penicillin. Accordingly the treatment of a non pregnant adult suffering from early syphilis which is advised here is (a) an intravenous injection of 0.45 gm neoarsphenamine and an intramuscular one of 0.3 gm bismuth oxychloride (or equivalent preparation in a dose containing 0.24 gm bismuth metal) on the first day (b) an injection *under* the fat of the gluteal region of 600 000 units of penicillin in the oil wax suspension already described on each of the following five days (c) 0.6 gm neoarsphenamine and 0.3 gm bismuth oxychloride on the seventh day (d) an injection of 600 000 units of penicillin on each of the following five days (e) a weekly injection of 0.6 gm neoarsphenamine and one of 0.3 gm bismuth oxychloride from the fifteenth to the seventy eighth day.

*In pregnancy* as already mentioned there is a strong body of opinion that only penicillin need be given. This may be sufficient to protect or to save the fetus but if the treatment is started early in the pregnancy and the course of penicillin alone is insufficient to eradicate the mother a infection a relapse of the latter would involve a risk of infecting the fetus. For this reason it would appear advisable to keep the mother under the influence of treatment throughout the pregnancy. On this principle and having regard to the possible oxytocic effect of penicillin indicating a cautious start the treatment recommended here is (a) 5 000 units of penicillin in water or saline every three hours for the first day (b) 10 000 units every three hours during the second day (c) one injection of 200 000 units in oil wax on the third day (d) one of 400 000 units in oil wax on the fourth to sixth day inclusive (e) one of 600 000 units in oil wax daily on the seventh to fourteenth day inclusive (f) a course of ten weekly injections of 0.45 gm neoarsphenamine concurrently with the same number of 0.20 gm bismuth oxychloride (or equivalent containing 0.16 gm bismuth metal).

The questions of further treatment after the above are discussed below.

In the above scheme the arsenical remedies recommended are neoarsphenamine and stabilarsan for the intravenous route and sulpharsphenamine for deep subcutaneous or the intramuscular one. The question arises What should be the dosage of oxophenarsine if a preparation of this class is substituted? The question is not easy to answer because the two types of remedy have not been compared on parallel lines in the prolonged schemes of treatment but on present evidence I should not feel justified in giving less than

0.14 gm oxophenarsine (in two or more injections) in place of 0.6 gm neoarsphenamine or similar remedy. In this connection it has to be remembered that rapidity of excretion which may be an advantage in an intensive scheme, may be a disadvantage in a prolonged one. Thus there is a strong body of opinion that in proportion to its arsenical content, arsphenamine is a more efficient remedy because it is less rapidly excreted than neoarsphenamine. On this principle, in the prolonged schemes neoarsphenamine and similar preparations have an advantage over oxophenarsine unless the latter is given twice weekly in place of neoarsphenamine once.

*Observation of the blood* before and after the treatment is important. If it is negative a month after the end of one of the courses outlined above, and if the spinal fluid is also negative it is justifiable to withhold further treatment testing the blood every month for the first three months, every three months for the remainder of the year following suspension of the treatment and every four months during the second year. If the blood is positive a month after the penicillin arsenic bismuth course, it may be difficult to decide whether to repeat the treatment or to continue only observation of the blood. In favour of the latter course is the fact that in a high proportion of cases which have been thus observed the blood has become negative without further treatment. In pregnancy the safe course appears to be to continue the treatment to term, to guard against infection of the foetus, in other early cases help in the decision may be obtained from quantitative tests of the blood which are particularly indicated now that the routine treatment lasts a much shorter time than suffices in many cases to clear the blood of reagin. If the tests show a considerable and progressive weakening of the reactions, it seems justifiable to wait, repeating the tests at short intervals, if the reactions show no weakening, or even increase in strength, repetition of the combined course of treatment is indicated.

On the question when and how often the spinal fluid should be examined opinions differ. Personally, I think that if the blood reactions have been negative from the first or have been finally reversed by the end of the second course, it is sufficient to test it when it is decided to suspend the treatment and at the end of the two years' period of observation which should follow completion of treatment. If the blood reactions persist beyond the end of the second course, or if a relapse occurs it is always advisable to test the fluid earlier. Against the practice of testing the fluid more frequently it must be said that lumbar puncture may be followed by headache of such severity as to make the patient quite determined never to risk a repetition of the experience.

*In later syphilis, i.e.* after the third or fourth year, the line of treatment depends very much on the involvement of the viscera and/or nervous system, which should always be carefully examined. It is most important in these later cases to test the spinal fluid. If this is negative, it is unlikely to become positive or that the central nervous system will become affected.

For tertiary syphilis affecting the external and supporting structures and for latent syphilis, in both cases when the spinal fluid is negative, the treatment may well be on the lines recommended above for early cases, but it will probably have to be continued far beyond this because in late syphilis one must reckon with the fact of many foci practically walled off from the general circulation and relatively inaccessible to remedies circulating therein. For this reason, if the blood is positive a month after the termination of the penicillin arsenic bismuth course, even though the quantitative tests show a considerable weakening in the strength of the reactions, it would be good

practice to give a course of ten injections of bismuth in conjunction with potassium iodide by mouth—the latter to stimulate the removal of walls enclosing foci—and to repeat the penicillin arsenic bismuth course a month after completion of the bismuth and iodide course. The difficult problem is to decide when to stop the treatment. Many syphilologists will not treat these cases after the clinical signs have gone, maintaining that the treatment only gets on the patient's nerves, and so forth. I am sure that this view is mistaken. Patients with latent syphilis who have not had any particular feeling of ill health often remark after the first or second course of treatment that they now feel better than they have done for years, it is as if an insidious depressor of health had been removed. Moreover, it is not true that the treatment of these cases has no effect on the serum reactions as can be seen by the quantitative serum tests. If the patient is relatively young, I usually treat until the strength of the reactions has shown no change for two or three courses and then advise continuation treatment at the rate of three courses in two years. The treatment may not be necessary from the point of view of combating the syphilitic infection after the first few courses have been given—there are plenty of people who have passed the allotted span and have not had a grain of treatment—but, in the individual case, nobody can say whether this is so or not at the time the patient is under it, and the treatment is given as an insurance against insidious damage by the spirochete.

If the spinal fluid is positive, the treatment must be governed by its effect on the fluid's reactions. If the fluid shows a marked improvement after the bismuth and iodide course which has followed the penicillin arsenic-bismuth course outlined above it is reasonable to continue on the lines already described giving a second penicillin arsenic bismuth course after the bismuth and iodide. But if the fluid shows no change after the bismuth and iodide course, the arsenical remedy in the next penicillin arsenic bismuth course may well be changed to tryparsamide. Prior to embarking on this change, one must be assured of no contraindication in the eye grounds. For an adult one starts with a dose of 1 gm tryparsamide dissolved in about 5 cc sterile water, which is given intravenously, the next week the dose is increased to 2 gm in 7 cc, and the week after that to 3 gm in 10 cc. Seven more injections complete the course. If any shimmering of the vision or other visual disturbance occurs, the tryparsamide treatment is stopped. It may be resumed cautiously (say with 0.5 gm) when the visual disturbance has disappeared. If the second penicillin arsenic bismuth course is followed by no improvement in the fluid, one considers the institution of pyreto therapy, during which a further course of penicillin may be given with advantage. Probably the most effective forms of pyreto therapy are by malarial inoculation (ten paroxysms of fever being allowed if possible before intervention with quinine), by means of physical apparatus and by intravenous injections of vaccine, for details of which other works should be consulted.

**Prevention and treatment of congenital syphilis**—If the mother has been treated well from early in the pregnancy, at least before the end of the fourth month, it is justifiable to withhold treatment from the infant pending the development of signs of congenital syphilis. In this positive serum reactions of the new-born infant's blood are not diagnostic, but increasing strength of the serum reactions is an indication to start treatment.

If it is decided that the infant requires treatment, this should be given on the same principle as described for early syphilis. As regards dosage, the total penicillin may be 80,000 units or more per kg, administered either in eighty three hourly injections of 1,000 units per kg over a period of ten days,

or one injection daily of calcium penicillin in oil wax, 8,000 units per kg, for the same period. The best arsenical component of the treatment is sulpharsphenamine, 0.02 gm per kg infant, as it can be given intramuscularly, and the dose of the bismuth compound should contain 0.004 gm bismuth metal per kg infant. On these principles a course of treatment for an infant weighing 4 kg would be: first day, 0.08 gm sulpharsphenamine and 0.2 cc of a 10 per cent suspension of bismuth oxychloride (or a dose of another bismuth preparation containing 0.016 gm bismuth metal), both injections being given intramuscularly; second to sixth day inclusive, a daily injection of 32,000 units penicillin in one injection or in eight as shown above; seventh day, repeat the sulpharsphenamine and bismuth; eighth to twelfth day inclusive, repeat the penicillin; fifteenth to seventy eighth day inclusive, give a course of weekly injections of sulpharsphenamine and bismuth.

The further treatment should be regulated on the same principles as shown above for early syphilis.

In older children and adults the treatment is on the same principles as in later stages of acquired syphilis.

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practice to give a course of ten injections of bismuth in conjunction with potassium iodide by mouth—the latter to stimulate the removal of walls enclosing foci—and to repeat the penicillin arsenic bismuth course a month after completion of the bismuth and iodide course. The difficult problem is to decide when to stop the treatment. Many syphilologists will not treat these cases after the clinical signs have gone, maintaining that the treatment only gets on the patient's nerves and so forth. I am sure that this view is mistaken. Patients with latent syphilis who have not had any particular feeling of ill health often remark after the first or second course of treatment that they now feel better than they have done for years, it is as if an insidious depressor of health had been removed. Moreover, it is not true that the treatment of these cases has no effect on the serum reactions as can be seen by the quantitative serum tests. If the patient is relatively young, I usually treat until the strength of the reactions has shown no change for two or three courses and then advise continuation treatment at the rate of three courses in two years. The treatment may not be necessary from the point of view of combating the syphilitic infection after the first few courses have been given—there are plenty of people who have passed the allotted span and have not had a grain of treatment—but in the individual case, nobody can say whether this is so or not at the time the patient is under it and the treatment is given as an insurance against insidious damage by the spirochete.

If the spinal fluid is positive, the treatment must be governed by its effect on the fluid's reactions. If the fluid shows a marked improvement after the bismuth and iodide course which has followed the penicillin arsenic bismuth course outlined above it is reasonable to continue on the lines already described, giving a second penicillin arsenic bismuth course after the bismuth and iodide. But if the fluid shows no change after the bismuth and iodide course, the arsenical remedy in the next penicillin arsenic bismuth course may well be changed to tryparsamide. Prior to embarking on this change, one must be assured of no contraindication in the eye grounds. For an adult one starts with a dose of 1 gm tryparsamide dissolved in about 5 cc sterile water, which is given intravenously, the next week the dose is increased to 2 gm in 7 cc, and the week after that to 3 gm in 10 cc. Seven more injections complete the course. If any shimmering of the vision or other visual disturbance occurs, the tryparsamide treatment is stopped. It may be resumed cautiously (say with 0.5 gm) when the visual disturbance has disappeared. If the second penicillin arsenic bismuth course is followed by no improvement in the fluid, one considers the institution of pyreto therapy, during which a further course of penicillin may be given with advantage. Probably the most effective forms of pyreto therapy are by malarial inoculation (ten paroxysms of fever being allowed if possible before intervention with quinine), by means of physical apparatus and by intravenous injections of vaccine, for details of which other works should be consulted.

**Prevention and treatment of congenital syphilis**—If the mother has been treated well from early in the pregnancy, at least before the end of the fourth month it is justifiable to withhold treatment from the infant pending the development of signs of congenital syphilis. In this positive serum reactions of the new-born infant's blood are not diagnostic, but increasing strength of the serum reactions is an indication to start treatment.

If it is decided that the infant requires treatment, this should be given on the same principle as described for early syphilis. As regards dosage, the total penicillin may be 80,000 units or more per kg, administered either in eighty three hourly injections of 1,000 units per kg over a period of ten days,

or one injection daily of calcium penicillin in oil wax 8 000 units per kg for the same period The best arsenical component of the treatment is sulpharsphenamine 0 02 gm per kg infant as it can be given intramuscularly and the dose of the bismuth compound should contain 0 004 gm bismuth metal per kg infant On the e principles a course of treatment for an infant weighing 4 kg would be first day 0 08 gm sulpharsphenamine and 0 2 cc of a 10 per cent suspension of bismuth oxychloride (or a dose of another bismuth preparation containing 0 016 gm bismuth metal) both injections being given intramuscularly second to sixth day inclusive a daily injection of 1 000 units penicillin in one injection or in eight as shown above seventh day repeat the sulpharsphenamine and bismuth eighth to twelfth day inclusive repeat the penicillin fifteenth to seventy-eighth day inclusive give a course of weekly injections of sulpharsphenamine and bismuth

The further treatment should be regulated on the same principles as shown above for early syphilis

In older children and adults the treatment is on the same principles as in later stages of acquired syphilis

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or one injection daily of calcium penicillin in oil wax 8 000 units per kg for the same period. The best arsenical component of the treatment is sulpharsphenamine 0.02 gm per kg infant as it can be given intramuscularly and the dose of the bismuth compound should contain 0.004 gm bismuth metal per kg infant. On these principles a course of treatment for an infant weighing 4 kg would be first day 0.08 gm sulpharsphenamine and 0.2 c.c. of a 10 per cent suspension of bismuth oxychloride (or a dose of another bismuth preparation containing 0.016 gm bismuth metal) both injections being given intramuscularly second to sixth day inclusive a daily injection of 1.000 units penicillin in one injection or in eight as shown above seventh day repeat the sulpharsphenamine and bismuth eighth to twelfth day inclusive repeat the penicillin fifteenth to seventy eighth day inclusive give a course of weekly injections of sulpharsphenamine and bismuth.

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## CHAPTER LXXVIII

### GONORRHOEA

**THE GONOCOCCUS**—The gonococcus is a non-motile Gram-negative diplococcus shaped like two kidneys with their notched sides in apposition. Multiplying by division, the pairs of cocci are said to be surrounded by a capsule. Each coccus of the mature organism measures  $1.6 \mu$  by  $0.8 \mu$  (Bumm, 1885), but fixing and staining tend to cause shrinkage. Debatable evidence exists that gonococci may vary by producing 'degeneration' forms incapable of reproduction and in staining properties. During the early hours of infection and in the chronic stages most of the organisms are extracellular, but during the acute stage intracellular cocci preponderate and their grouping in the protoplasm of the polymorphonuclear cells is characteristic. Formerly unbelievably, extracellular gonococci are just as typical and indicative of infection as the intracellular ones. Innumerable attempts to distinguish various types or strains of gonococci have had indifferent success.

The optimum cultural temperature is not always that of the body,  $37^{\circ}\text{C}$ , for some strains prefer the lower temperature of the urethra,  $35^{\circ}$  to  $36^{\circ}\text{C}$ . Gonococci prefer a moist atmosphere with an increased  $\text{CO}_2$  tension on special media, too numerous to mention here, with a pH 7.3 to 7.5. Generally the culture tubes or plates are incubated for forty-eight hours at  $36^{\circ}\text{C}$ , preferably in 10 per cent carbon dioxide.

**INCUBATION**—The average time is four days, common limits vary from two to twenty-two days, but urethritis with an incubation period of more than twelve days is more likely to be non-gonococcal, and this probability increases with each succeeding day. Uncommon limits may be as short as twelve hours and a few cases of over three weeks are on record. The infection may be transferred during the incubation period before symptoms develop.

**VITALITY**—Desiccation kills the gonococcus, any drying agent, e.g. the sun, a dry wind, heat from a fire or radiator, decontaminates as soon as the infected article is dry. Wet towels, sheets, pyjamas, sponges, baths, etc., readily harbour infection, as moisture powerfully assists the organism to retain its vitality, hence the gonococcus bathed in tissue fluids is not easily eradicated. The writer (1933) has proved that  $114^{\circ}\text{F}$  for forty minutes in the cervical canal fails, although it is destroyed at  $104^{\circ}\text{F}$  in the test tube. Outside the tissues viability is poor, weak antiseptics and sodium oleate in soap lather are gonococcidal.

**Pathology**—The columnar epithelium of the urethra and its glands is more susceptible to the gonococcus and its toxin than the squamous epithelium of the fossa navicularis and the transitional mucosa of the prostatic urethra. The columnar cells destroyed by a gonorrhoeal infection are replaced by flattened squamous epithelium, which is more resistant to subsequent infections. The fossa navicularis being a cul-de-sac only  $\frac{1}{2}$  in inside the meatus is often a persistent site of infection despite its resistant structure.

Within a few hours of infection gonococci have passed between the columnar cells into the perilymphatic spaces and the speed of penetration is so rapid that within thirty-six hours they are well into the deeper submucosal spaces (Pelouze, 1928).

They have also begun to extend beyond the original areas of implantation by direct spread along the mucosa (Walker 1913) which is aggravated by excess of alcohol and sexual excitement. The rapidly multiplying organisms manufacture a most potent toxin so irritating that the epithelium is stripped from its base by the resulting tissue reaction together with an outpouring of serum and polymorphonuclear leucocytes.

The infection continues to spread to the other structures of the genito-urinary tract not only by direct continuity but also into the subepithelial connective tissues along the capillary lymphatic spaces and lymphatics and occasionally directly into the blood stream via the capillary blood vessels. Sometimes the process is so severe that a lymphangitis develops with suppuration of the adjacent lymphatic glands. By these routes the infection extends in the male to the prostate seminal vesicles and epididymes in the female to Bartholin's glands Skene's ducts vagina cervix cervical canal uterus Fallopian tubes ovaries and peritoneum and in both sexes to the bladder ureters kidneys and their pelves. The transitional epithelium of the bladder is more resistant a general cystitis is uncommon for the infection seldom spreads beyond the trigone. The organisms and toxin have a predilection for epithelial tissue and endothelial lined cavities so that joints synovial sheaths tunica vaginalis peritoneum pleura heart etc. may be involved.

As the inflammation in the urethra and its glands subsides soft and then hard infiltrations may form with accompanying loss of elasticity through degeneration and fibrosis of cells. This may result in stricture formation along the urethra and fibrosed or even keratinized nodules at the sites of destroyed follicles in the urethra or in the glandular tissue of the prostate and seminal vesicles.

**Prophylaxis.**—Condoms of superior quality carefully used afford the most efficient protection. Immediately after intercourse chemical prophylaxis properly carried out by a sober man is effective in about 90 per cent. of cases. After micturition the external genitalia thighs and pubic region should be washed thoroughly with soap and water or mercury perchloride 1 in 1 000 and the urethra irrigated with a non irritating solution such as potassium permanganate 1 in 3 000 or mild silver proteinate 10 per cent. (cargentos solargentum) or silver protomate 1 per cent. (protargol argyrol) may be held in the urethra for five minutes.

If within four hours of exposure all parts should be muncted with 30 per cent. calomel ointment and lint or gauze wrapped around the genitalia to protect the clothing. If later than twelve hours it is advisable to irrigate with potassium permanganate 1 in 3 000 twice or thrice daily for two three or more days. In women in addition to the above the cervix cervical canal and vaginal fornices should be painted through a speculum with tincture of iodine gentian violet or bright green. In addition sulphadiazine should be given prophylactically. Jones (1942) prescribed 3 gm. of sulphathiazole at breakfast 2 gm. at noon and 1 gm. in the evening of the day following exposure to 350 seamen none of whom developed gonorrhoea or chancroid. Osgood (1941) advocates sulphathiazole powder (10 to 20 per cent.) suspended in a water soluble lubricating jelly for local application.

## GONORRHOEA IN THE MALE

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As the inflammation in the urethra and its glands subsides, soft and then hard infiltrations may form with accompanying loss of elasticity through degeneration and fibrosis of cells. This may result in stricture formation along the urethra and fibrosed, or even keratinized, nodules at the sites of destroyed follicles in the urethra or in the glandular tissue of the prostate and seminal vesicles.

**Prophylaxis**—Condoms of superior quality, carefully used, afford the most efficient protection. Immediately after intercourse chemical prophylaxis, properly carried out by a sober man, is effective in about 90 per cent of cases. After micturition the external genitalia, thighs and pubic region should be washed thoroughly with soap and water or mercury perchloride 1 in 1,000, and the urethra irrigated with a non-irritating solution such as potassium permanganate 1 in 3,000, or mild silver proteinate 10 per cent (cargentos, solargentum), or silver proteinate 1 per cent (protargol, argyrol) may be held in the urethra for five minutes.

If within four hours of exposure all parts should be muncted with 30 per cent calomel ointment and lint or gauze wrapped around the genitalia to protect the clothing. If later than twelve hours it is advisable to irrigate with potassium permanganate 1 in 3,000, twice or thrice daily for two, three or more days. In women, in addition to the above, the cervix, cervical canal and vaginal fornices should be painted through a speculum with tincture of iodine, gentian violet or bright green. In addition, sulphadiazine should be given prophylactically. Jones (1942) prescribed 3 gm of sulphathiazole at breakfast, 2 gm at noon, and 1 gm in the evening of the day following exposure to 350 seamen, none of whom developed gonorrhoea or chancroid. Osgood (1941) advocates sulphathiazole powder (10 to 20 per cent) suspended in a water-soluble lubricating jelly for local application.

### GONORRHEA IN THE MALE

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**Prophylaxis**—Condoms of superior quality carefully used, afford the most efficient protection. Immediately after intercourse chemical prophylaxis, properly carried out by a sober man is effective in about 60 per cent of cases. After micturition the external genitalia, thighs and pubic region should be washed thoroughly with soap and water or mercury perchloride 1 in 1,000, and the urethra irrigated with a non irritating solution such as potassium permanganate 1 in 3,000, or mild silver proteinate 10 per cent (cargentos, solargentum), or silver proteinate 1 per cent (protargol, argyrol) may be held in the urethra for five minutes.

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### GONORRHOEA IN THE MALE

**Acute stage—ACUTE ANTERIOR URETHRITIS**—Attention is first attracted by an uncomfortable irritation in the urethra and a frequent desire to urinate. Then a sensation of heat in the penis, slight dysuria and the appearance of a

thin creamy mucoid discharge at the meatal lips, which look reddened and everted. Within twenty-four hours the increasing discharge becomes thicker yellowish and purulent and micturition more painful. Only in the minority of cases where the local tissue reaction is acute, is pain experienced. In recent years dysuria is less severe than formerly, symptoms and tissue-reaction are less marked and the infection being more insidious, tends to be more persistent. The glans penis becomes congested, swollen and cedematous, frequency of micturition is more urgent, the genitalia feel tumescent and heated, while distressing erections known as "chordee" occur particularly at night. The patient looks ill and anæmic, has rheumatic pains around the pelvis and in the limbs, headache, pyrexia to 100° F., and passes thick, cloudy urine. After five to ten days the attack abates, the discharge lessens, thins and whitens, and the local inflammatory signs subside. Later the discharge becomes slight, watery and intermittent, and only a "morning drop" may be seen.

**ACUTE POSTERIOR URETHRITIS**—The posterior urethra is affected in 60 per cent of patients. Symptoms may be negligible in mild cases, or the onset may be signalled by increased frequency, especially nocturia, a feeling of congestion, heaviness, and pain in the perineum, an exacerbation of erections, pain and blood at the end of micturition, and backache.

**Subacute stage**—If the patient is fortunate, the discharge ceases within a fortnight, the mucosa recovers and the urine clears, but it still contains pus threads from infected follicles.

**Chronic stage**—The infection is considered chronic if it is not cured within a month, the anterior and posterior urethra, vesicles and prostate must be thoroughly investigated to determine the exact location of the persisting foci, which may be situated in Littre's glands, Cowper's glands, the prostate, or the vesicles. Prolonged irrigation with concentrated solutions or excessive caustic instillations, may have caused a chemical urethritis, or unskilful instrumentation may have traumatized the urethra. Vesiculitis (60 per cent) is the common cause of chronicity, prostatitis only in about 30 per cent.

Most cases complain of a slight watery or whitish discharge, visible only in the mornings (morning gleet), with pus threads in the urine. These signs may be absent for several days at a time and then recur at intervals. Some times a gumming of the meatal lips on awakening may be the only indication of a virulent infection.

**Diagnosis**—To determine whether an anterior or posterior urethritis exists, or both are present, the urine should be held for several hours. Then the anterior urethra is washed out thoroughly with mercury oxycyanide 1 in 5,000, and the urine voided. If it is hazy and contains pus threads, the posterior urethra is infected. It is probably free of infection if the urine is clear and has no pus or threads. THOMSON'S TWO-GLASS EXAMINATION provides a rough test of this. The patient is told to pass the first half of his urine into one glass and the rest into a second glass. If the first glass is cloudy with pus or contains threads, and the contents of the second glass are clear and without threads, the posterior urethra is probably free and the infection restricted to the anterior urethra. This test is not infallible, for the products of a mild posterior urethritis may be washed into the first glass, leaving a clear urine in the second. Both divisions of the urethra are involved if both glasses contain pathological elements.

**EXAMINATION OF THE PROSTATE AND SEMINAL VESICLES**—These organs may be infected although both glasses contain normal urine. With a rubber cot on the first finger in the rectum and the patient in the knee-elbow position or leaning over a couch, with toes turned inwards, first the vesicles and then

the prostate are palpated and massaged while the free hand pressing on the perineum forces these organs against the examining finger. This expresses the contents of the vesicles by massaging them downwards and towards the mid line the secretion at the meatus previously cleansed with ether or alcohol which evaporates quickly is transferred to a culture or glass slide similarly the prostatic contents are collected. The naked eye can differentiate the vesicular from the prostatic secretion normally the former is thick viscid and greyish yellow the latter is thin whitish and opalescent. In these secretions 6 to 8 pus cells per  $\frac{1}{2}$  in field are normal any number above that is considered pathological. The significance of pus cells depends not so much on their number as on the state of the patient at the time of examination but little reliance can be placed upon the presence or absence of pus cells in prostatic secretions in determining whether a gonococcal infection is present.

**EXAMINATION OF A CHRONIC ANTERIOR URETHRITIS**—If the above tests show that the posterior urethra vesicles and prostate are not involved soft and hard infiltrations infected follicles and strictures in the anterior urethra must be investigated and treated with sounds acorn tipped bougies and the urethroscope.

**APPEARANCES OF THE URINE**—In acute gonorrhoea the urine is hazy at first. It then becomes acid turbid and full of small irregular pus shreds from the inflamed mucosa. As the infection abates the urine clears except for numerous small white tortuous threads of pus from infected Littre's follicles and larger shreds of mucopus from Morgagni's crypts. Gradually these become fewer contain less pus and more mucus and so tend to remain longer in suspension before they sink. Pus threads are heavy and sink and indicate an active condition. Mucus shreds are light and float and come from sites of a more chronic process. In chronic gonorrhoea the urine is full of small fine shreds white pin point specks and comma shaped threads in chronic posterior urethritis. Larger thick coarse ones are seen if an abscess is draining. Chronic prostatitis is indicated sometimes only after massage by small pin point specks of pus hook shaped shreds of mucopus and comma threads from the prostatic ducts. In chronic vesiculitis the urine after massage contains a large amount of debris long stringy mucopurulent worm like casts and large grey casts from the vesicular walls. Some have a core of pus attached to the end of a shred or cast of mucopus (these may also come from a chronic cowperitis or large follicle anywhere along the urethra). With increasing chronicity oval tapioca like casts or smaller sago bodies or small sugar granules are seen.

**URETHROSCOPIC APPEARANCES**—In the male the normal anterior urethra varies in shape and colour and considerable experience is necessary to detect small abnormalities. Striae radiating from the lumen of the urethra divide the bright red mucosa into folds which glisten with a clear alkaline mucoid secretion from Littre's glands. Most of these ducts ( $\frac{1}{2}$  to 1 mm in diameter and 1 mm to 2 cm in length) open in a double row along the roof and are not easily detected as they do not protrude above the level of the surrounding mucous membrane.

The crypts of Morgagni mostly in the roof are horseshoe or crescentic shaped fossae with their openings directed towards the meatus. Cowper's ducts open into mucosal folds in the floor of the bulbous urethra.

The normal posterior urethra contains the verumontanum, a pink hump 1 to 2 mm broad which runs along the floor of the urethra for 8 to 14 mm with the orifice of the sinus pularis on its summit. Anteriorly it tapers into

blue 1 per cent and zinc sulphadiazine 5 per cent, soothe a painful urethra. Mercurochrome 1 per cent, protargol 1 in 1,000, silver nitrate 1 in 10,000, zinc permanganate 1 in 8,000, zinc sulphocarbolate 5 per cent, acriflavine 1 in 5,000, argyrol 1 in 1,000, are useful in selected cases after the initial inflammation has subsided.

**DRUGS**—Penicillin and the sulphonamides have reduced the length of treatment mostly to a matter of days instead of the weeks and months previously required.

### PENICILLIN

Penicillin being the most potent agent against gonorrhœa, is the first choice before other lines of treatment. If unobtainable one of the sulphonamides, preferably sulphadiazine, should be given, but penicillin should be administered to sulphonamide resistant cases (whose numbers seem to be increasing) as soon as failure to respond to one course of the drug is recognized.

As with the sulphonamides penicillin-resistant strains of gonococci do occur. Should this be so, combined penicillin and sulphonamide treatment is advantageous.

*In vitro*, the gonococcus is the most susceptible of the pathogenic bacteria to penicillin. Even most sulphonamide-resistant strains of gonococcus are destroyed in 1-200,000 dilution of penicillin, but some require 1-32,000 dilution before they are inhibited (Abrahams). Cultural tests by Herrell showed that visible organisms of sulphonamide resistant strains are absent after four hours' contact.

*In vivo*, this non-toxic antibiotic agent has revolutionized treatment and should be used whenever available, as it is equally effective both in acute and chronic gonorrhœa. The infection can be rapidly controlled even after it has existed for many months. Sulphonamide resistant and those who are hypersensitive to sulphonamides, especially those with metastatic symptoms in both sexes, including pregnant women and children with vulvo vaginitis respond well. Both untreated and sulphonamide-resistant patients do not appear to differ in their response to penicillin. It produces no toxic effects even in doses far exceeding those required for therapeutic purposes, and is not contraindicated either by pregnancy or by a concurrent infection with *Trichomonas Vaginalis*.

Owing to its high degree of solubility, it readily reaches the involved tissues and effects a higher percentage of cures more speedily and with more certainty than the sulphonamides. Mildly estimated over 80 per cent successful results are obtained. When 129 sulphonamide-resistant cases were treated by Keefer with penicillin, 125 became symptomless and bacteriologically negative within nine to forty-eight hours. The first negative cultures were obtained within seventeen to forty-eight hours, and twenty-four-hour urines showed that between one-third and one-half of the penicillin was excreted through the urinary system.

The potency of the various preparations of penicillin varies considerably and penicillin resistant strains of gonococci are increasing. Therefore, higher rather than lower doses should be used to avoid penicillin resistance and to reduce the incidence of gonococcal carriers.

**Administration**—Only 10 to 26 per cent of penicillin is found in the urine after oral administration, 33 per cent after intramuscular injections of penicillin in beeswax, and 65 to 80 per cent after intramuscular injections of aqueous penicillin. A cure by the oral route is uncertain and requires three to six times the intramuscular dosage. Concentration of aqueous penicillin



can be maintained by multiple intramuscular doses throughout the day or by more conveniently giving only one or two injections per diem of a preparation with oil or beeswax which retards absorption and yet maintains a prolonged concentration of the drug. There is no significant difference in the results obtained by these two methods.

The intramuscular or deep subcutaneous route is the best (Fleming) as it maintains the penicillin content of the blood rather longer than intravenous injection. After an intramuscular injection the penicillin content of the blood is at its height in about six minutes so little time is gained by the intravenous route. Gluteal injections cause less pain than those into the deltoid or triceps.

*Dosage*—In acute gonorrhoea a total of at least 300 000 units and preferably 500 000 units should be given within twenty four hours. The scheme commonly employed if the aqueous solution is used is to give five injections of 60 000 to 100 000 units at two hourly intervals. If a delayed action preparation is used the total dose of 300 000 to 500 000 units in beeswax or oil can be given in one injection or the dose can be divided with advantage into two injections with a ten hour interval.

Using penicillin G the commercial preparation in general use the irritation discharge and frequency disappear in two or three days in 80 per cent of cases. Better results may be obtained with penicillin V which is more potent to the gonococcus than penicillin G.

If gonococci persist in the smears on the second day the injections of penicillin should be repeated at once. In these refractory cases sulphadiazine or sulphathiazole may be combined advantageously with penicillin. A possible synergistic action between it and the sulphonamides raises the cure rate about 5 per cent.

Later and more chronic types especially those with metastatic complications require larger and more prolonged dosage. In vesiculitis and prostatitis to ensure satisfactory results it is advisable to promote adequate drainage by rectal massage before penicillin or a sulphonamide is administered. As prolonged dosage is required 300 000 to 500 000 units in beeswax or oil daily for a week at a time should be given together with the requisite adjuvant treatment. It may be necessary to repeat such courses of therapy at varying intervals especially in those chronic cases of vesiculitis and prostatitis with indifferant drainage.

In chronic gonococcal arthritis (even in those difficult sulphonamide resistant cases in which although the clinical picture is typical and the gonococcal fixation reaction of the blood serum is positive the smears and cultures are persistently negative) larger doses than usual 100 000 units daily for four days have been successful. An arthritis of the wrist with early destruction of the joint responded so well to forty eight hours treatment with penicillin that the joint functioned normally.

Arthritis may be treated locally. Dawson and Hobby injected 10 000 units daily for three days into the knee joint all evidence of the infection having subsided the patient was discharged on the fifth day.

Similarly females respond as readily as males including those with endometritis and salpingitis and children with vulvo vaginitis. In the latter a single injection of 100 000 units is adequate in most cases but most women require a higher dosage (500 000 units at least) than men. Severe or complicated cases should be given 500 000 units daily for five or six days in succession.

SULPHONAMIDES should be given as soon as the diagnosis is established. Postponement of administration of the drug until immunity is raised by

vaccines etc increases the risk of complications and relapse Delay has no advantages and jeopardizes a successful result *A full dosage must be given* Small, insufficient doses render cases more resistant to subsequent treatment by developing sulphonamide resistant (apart from born resistant) gonococci Felke (1938) Herrold (1938) Levaditi and Vaisman (1938) have reported gonococcal strains resistant to sulphanilamide, and Westphal, Charles and Carpenter (1940) developed strains resistant to sulphapyridine The dosage generally used in ambulatory cases is about 4 gm daily for four to seven days after an initial dose of 2 to 3 gm to obtain the maximum concentration in the serum as quickly as possible Unfortunately, the sulphonamides, even when they fail to cure, raise false optimism by abating symptoms and relieving pain and a belief that a cure is almost within grasp if administration is continued The drug which acts in the tissues and not in the excretion products eliminated in the urine (Nesbit, 1940), should not be given for more than ten to fourteen days at a time prolonged action reduces the patient's resistance and increases the number of gonococcal carriers If one course of a sulphonamide is unsuccessful, a subsequent course of the same drug is also likely to fail, penicillin or a different sulphonamide should be exhibited, but if a second course is necessary, a rest period of seven to ten days should intervene between the courses to lessen the risk of agranulocytosis Alkaline mixtures should be prescribed simultaneously to prevent crystallization in the urinary tract, sulphathiazole is twice as soluble in alkaline as in acid urine, and the bacteriostatic activity of the sulphonamides is augmented

All the sulphonamides are toxic in varying degree causing nausea, vomiting, skin rashes kidney obstruction and agranulocytosis These effects may be minimized by a large fluid intake keeping the urine alkaline, preventing cyanosis by methylene blue 2 gr to each 0.5 gm of sulphonamide or by 10 c.c. of 1 per cent solution of methylene blue intravenously, and by reducing the proteins and increasing the carbohydrates in the diet Uncommonly, an alkaline urine fails to prevent crystalluria, after twelve hours of anuria, the "inductotherm" may be applied to the loins, but if ineffective, cystoscopy and ureteric catheterization should be performed

*Sulphanilamide* is the least effective of the sulphonamides and the most prolific in producing gonococcal "carriers" At first, cure rates up to 90 per cent were claimed, but it is now generally recognized that a more correct estimate is only 25 to 40 per cent of cases Sulphapyridine, sulphathiazole, and sulphadiazine give higher cure rates than sulphanilamide, but in some areas as high as 25 per cent of cases may have an inborn resistance to sulphonamides

*Sulphadiazine* gives a higher percentage of cures than the other sulphonamides and is less toxic Mild reactions leucopœmia and hæmaturia, with the occasional passage of sulphadiazine concretions occur if fluids are restricted, but the minor reactions—nausea, vomiting, cyanosis, dizziness, depression and headaches, common with other sulphonamides—are rare

La Towsky and his collaborators (1942) state that sulphadiazine causes the prostatic fluid to become free from living gonococci sooner than any of the other sulphonamides, and the comparative results issued by the American Neisserian Medical Society and the U.S. Public Health Service under their co-operative plan of pooling the reports from a group of clinics show that sulphadiazine, being more effective therapeutically and less toxic than sulphathiazole, is the drug of choice

The following sulphonamide treatment for acute gonorrhœa is used for ambulatory patients at St Thomas's Hospital, when penicillin is not given

*Drug*—Sulphadiazine as its low toxicity permits a high dosage over a short period and it is more effective than any of the other sulphonamides

*Dosage*—Immediately diagnosis is established an initial dose of 2 gm followed by 4 gm (8 tablets) daily for five to seven days according to the physique of the patient the first two tablets per diem after breakfast and the last tablet just before retiring at night while the remaining tablets are taken singly and spaced throughout the day each tablet being crushed between the teeth or taken in milk if possible Simultaneously the urine is kept alkaline by potassium citrate 35 gr tds with tincture of hyoscyamus at discretion and the avoidance of constipation by aperients

*Intolerance*—The tablets should be stopped immediately and fluid intake pushed if hæmaturia and pain in the renal angle suggest crystalluria or a chronic nephritis aggravated by the drug Three thousand patients have ingested 100 000 tablets of sulphadiazine without the occurrence of a single example of anuria and only two transient cases of hæmaturia

*IRRIGATIONS*—Once or twice daily warm potassium permanganate 1 in 8 000 for the first seven days and 1 in 6 000 for the second seven days the irrigations to be given for at least ten days irrespective of when the discharge ceases

*FLUID INTAKE*—Eight to ten pints of tea or water per diem for ten days

*DIET*—Preferably increased carbohydrates and less proteins Eggs onions aspirin phenacetin are not contraindicated

*REST*—Preferably bed for the first few days but this is not essential

*SMOKING*—Should be restricted and stopped if dizziness occurs

*TREATMENT OF SUBACUTE GONORRHOEA*—The urethra should be irrigated daily and massaged once or twice weekly for a fortnight while it is dilated by two or three metal sounds (Charriere 16 22) This opens the ducts of the infected follicles assists drainage blood supply and the absorption of soft infiltrations

In skilled hands Kollmann's straight anterior flushing dilator twice a week is more efficient dilatation from 22 to 45 Charriere is shown on a dial and the expansion of the blades is regulated by slowly screwing the handle to the point of discomfort (Charriere 30 35) If this is exceeded a ruptured mucous membrane may cause hæmorrhage and pain Two pints of mercury oxycyanide 1 in 5 000 are passed from a reservoir through the instrument in the urethra to a bowl between the legs of the recumbent patient The instrument is withdrawn while the solution is still flowing and without completely closing the blades so that the mucosa is not nipped To pass instruments soon after an irrigation with potassium permanganate is difficult and should not be attempted Owing to its astringent action the mucosa is liable to be injured or torn Daily irrigations with potassium permanganate should be continued but it is too astringent to use through this instrument

*TREATMENT OF CHRONIC GONORRHOEA*—*Treatment of chronic vesiculitis and prostatitis*—Emptying the inflammatory products in these organs is most effectively accomplished by regular massage per rectum two or three times weekly for about six weeks All other adjuvant forms of treatment including penicillin and the sulphonamides may fail unless drainage is established Parallel strokes of the finger beginning at the tip of the vesicle are made gently and firmly but without force downwards towards the mid line covering the vesicular and prostatic areas on both sides The bladder is emptied after each massage and the whole urethra irrigated with a mild antiseptic solution or an instillation injected through an Ultzmann's syringe of 2 to 3 cc of glycerine and ichthyol 10 per cent mercurochrome 1 in 1 000 silver nitrate

the inflammation except in severe cases, when a dorsal slit may be necessary to relieve the tension of the paraphimosis on the glans and to procure free drainage. Mild paraphimosis can be reduced by pressure of the thumbs on the glans while the fingers simultaneously pull the prepuce forward.

**PARA-URETHRAL AND PERIURETHRAL (TYSONITIS) DUCT INFECTION**—Occurring about the second week with dysuria and difficulty in micturition the swelling requires hot antiseptic baths and if fluctuation occurs, aspiration to prevent the formation of a fistula. A large abscess should be incised.



FIG. 403

Subacute gonorrhoea and tysonitis (Periurethral abscess to left of frenum.)

**LITTRITIS**—Littre's glands, being tortuous and pointing from or towards the meatus or at right angles to the urethra, are admirable foci for gonococci and the frequent cause of relapse. Irrigating fluids, antiseptic instillations and applications through the urethroscope or the cauterizing or caustics such as fused silver nitrate or iodized phenol, reach the bottom of the follicles with difficulty. In the early stages but not until the discharge and the haze in the urine have disappeared, drainage from the glands should be promoted firstly by dilatation of the urethra with anterior straight metal sounds and later with Kollmann's straight flushing dilator. The passage of these instruments also prevents soft and hard infiltrations and the subsequent formation of strictures. Finally, when only two or three infected follicles remain, these may be destroyed by cauterization or caustics through the urethroscope.

The meatus is the narrowest part of the urethra, and **MEATOTOMY** is indicated when a congenital narrowing or old scarring further reduces its calibre so that a urethritis is prolonged by the poor drainage, or when instruments, especially the urethroscope, are difficult to pass.

**PERIURETHRAL ABSCESS**—Blockage of the urethral glands causes indurated tender swellings anywhere along the undersurface of the urethra, these abscesses are associated generally with a hard infiltration or a stricture, or with any other process which impedes drainage, such as plugging the meatus with cotton wool to prevent soiling garments and constricting the penis with rubber bands or tight bandages. The three common sites are the fossa navicularis on either side of the frenum (tysonitis), the bulb at the penoscrotal junction and the perineum



FIG. 409

Periurethral abscess in subacute gonorrhœa

Fortunately, most abscesses discharge into the urethra, but if through the skin a troublesome urinary fistula is formed. Early aspiration may prevent this latter complication, but incision may be unavoidable. Once or twice daily for several days the cavity should be washed out through the aspirating needle with proflavine 0·1 per cent, silver nitrate 1 per cent, potassium permanganate 1 in 3,000, or penicillin.

**COWPERITIS**—More often than not this condition is overlooked, but perineal or anal aching accompanied by intermittent gleet should arouse suspicion. This is confirmed if the gland, which is not palpable normally, can be felt to one side about  $\frac{1}{2}$  in. inside the anal orifice between the finger and the thumb at the side of the rectum. The gland should be massaged twice weekly for four to six weeks. Difficulty in micturition or a painful swelling in the perineum indicates that the blocked duct has caused an abscess which may burst preferably into the urethra, or at the perineum. Hot baths, hot or cold fomentations, rest, and gentle massage of the gland assist resolution. Rupture into the urethra may be aided, after local anaesthesia of the urethra with novocaine 1 to 3 per cent, by the passage of a sound or the urethroscopic knife. If the pus cannot be drained by this route, the abscess should be aspirated through the perineum before it forms a fistula by bursting through the skin or if too large it should be incised under local anaesthesia and the cavity drained and picked. Eversion of the gland is the only satisfactory remedy if a urinary fistula results.

**PROSTATITIS**—When the posterior urethra becomes infected (about 60 per cent of all cases) direct and perilymphatic spread of the infection along and about the prostatic duct may involve the prostate too. Symptoms vary with severity: frequency, dysuria, heaviness, discomfort and pressure in the perineum, low backache with tenderness at the sacro iliac joints, pain referred down the thighs and in the severe cases difficulty and even retention of urine. Three types exist according to the degree of anatomical spread of the infection—

1 *Catarrhal*—The commonest and mildest form is a congestion of the prostatic ducts and glandular tissue near the prostatic urethra which resolves without trouble in a few days with rest and hot baths. The prostate is slightly enlarged and feels tender, soft and doughy.

2 *Follicular*—In this more extensive impregnation palpation reveals one or more tender areas of irregular consistency in one or both lobes or involving a whole lobe. Heaviness and a dull ache rather than pain in the perineum with occasional bouts of frequency predominate.

3 *Parenchymatous*—In this the severest type a diffuse infiltration throughout the prostate including the interstitial tissue in the most extensive and intractable cases is shown by an india rubber consistency with pain rather than tenderness on palpation and a marked enlargement so that the prostate bulges noticeably into the rectum. At first the prostate feels firm and cellulitic and the urethral discharge may be scanty but later the prostate becomes softer and boggy and the discharge increases. The symptoms are distressing in the acute stage: frequency, dysuria, hæmaturia, pyrexia ( $100^{\circ}$  to  $101^{\circ}$  F) with rigors, pain in the back, perineum, rectum and penis. The more serious cases are indicated by retention of urine and tenesmus on defecation.

The catarrhal type may resolve rapidly and completely but the follicular and parenchymatous cases generally pass through the subacute stage to become chronic with or without abscess formation.

**PROSTATIC ABSCESS**—The patient looks and feels ill and the above symptoms of prostatitis are aggravated: pyrexia to  $103^{\circ}$  to  $104^{\circ}$  F, acute pain in the perineum, urgent frequency, difficulty of micturition with occasional retention. The prostate is so tense and painful if an abscess be present that on rectal examination the patient struggles to prevent the palpating finger reaching the large rounded swelling protruding into the rectum. Mostly (70 per cent) the abscess ruptures into the urethra, immediate relief follows a sudden discharge of blood stained pus at the meatus and this continues especially at the end of micturition and defecation. Alternatively the abscess may discharge into the rectum or point through the skin of the perineum.

At both sites the fistula may heal spontaneously or require surgical repair.

**VESICULITIS**—The writer (1935) has emphasized that the vesicles are infected in practically every patient with a posterior urethritis. *Vesiculitis not prostatitis is the commonest cause of chronic recurrent gonorrhœa.* Prostatitis is readily diagnosed but this is not always so with vesiculitis and infection goes up and around the larger ejaculatory ducts as easily as it does along the smaller but more numerous prostatic ducts. Gonococcal vesiculitis may be acute, subacute or chronic. McCrea (1940) describes the following varieties: (1) catarrhal (2) suppurative (3) interstitial (4) perivesiculitis (5) pseudo abscess—partial obstruction and some degree of obstruction (6) abscess or empyema—complete obstruction with retention (7) gangrenous.

In early vesiculitis the symptoms and signs may be so slight and the onset so insidious that the condition is undetected but when it becomes acute the picture changes dramatically.

(a) *Acute vesiculitis*

*Symptoms*—Dysuria frequency heaviness and pains in the perineum, sacral and sacro-iliac regions referred pain to the tip of the penis and rectum, frequent erections and painful hæmorrhagic emissions which are almost pathognomonic

*Signs*—Unilateral or bilateral palpable tender boggy vesicles, hazy urine in all glasses with a profuse discharge

(b) *Subacute vesiculitis*

*Symptoms*—As above, but lessened in intensity with a medium amount of discharge

*Signs*—The vesicles are not so tender or so readily palpable, but areas of induration begin to develop

(c) *Chronic vesiculitis*

*Symptoms*—Most of the above symptoms have disappeared, but an aching in the sacro iliac region occasionally persists The discharge, too, is occasional but slight and the urine is clear in all glasses except after massage per rectum

*Signs*—The vesicles feel thickened and indurated, with irregular areas of tenderness on deep pressure Sometimes they are hardly palpable but pus in the vesicular secretion reveals their pathological condition Craggy nodules may be felt in very chronic cases

**EPIDIDYMITIS**—Although the openings of the ejaculatory ducts, through which the infection passes along the vas to the globus minor, are so close together epididymitis is generally unilateral, only 10 per cent being bilateral The acuteness of the condition, aggravated by alcohol, sexual excitement, physical exertion too early instrumentation, violent massage, or irrigation under too strong a pressure produces blockage of the ejaculatory ducts by plugs of mucus and congestive oedema around the verumontanum This distends the vesicle with pus which regurgitates down the vas to the globus minor Tenderness in the groin along the course of the vas is the initial warning that the epididymis may become involved Pain and swelling along the vas accompanied by an aching heaviness in the testicle follows, and the urethral discharge lessens Then the epididymis becomes so painful and the patient feels so ill that he goes to bed with a pyrexia of  $102^{\circ}$  to  $104^{\circ}$  F The discharge dries up but the urine in all glasses remains hazy and full of pus The swollen scrotum is tense and excessively painful to touch, its skin may become red and inflamed but a pure gonorrhœal epididymitis never suppurates Should this happen, the infection is more likely to be tuberculous or coliform Usually in ten days, but within three or four days in mild cases, the swelling and pain subsides, the discharge returns, and the patient can resume work, but an indurated nodule at the globus minor may persist for months Gonococcal epididymitis is almost invariably accompanied by a vesiculitis as well as a posterior urethritis and a prostatitis

*Treatment of epididymitis*—The patient should rest in bed with the weight of the scrotum supported by a pillow or rubber hot water bottle While being treated as an ambulatory case, a suspensory bandage should be worn Injections of penicillin and one of the sulphonamides, preferably sulphadiazine with potassium citrate and hyoscynamus, should be given orally and urethral irrigations suspended Daily hot baths, hot fomentations, long or short wave diathermy, and the application of linseed poultices, antipylodistine, lotions of glycerine and magnesium sulphate, glycerine and belladonna, or lead and opium, relieve the inflammation, while erections may be prevented and sleep assisted by bromide, luminal, medinal or chloral hydrate, and

suppositories of morphia atropin belladonna or iodine. Alcohol and sexual excitement are taboo and only a milk diet permitted until the pyrexia subsides. These procedures relieve the pain within a few hours to two or three days. recovery takes five to ten days. Therefore operative procedures such as puncture decapsulation and epididymotomy are hardly warranted except in severe or bilateral cases where sterility may be less likely if these methods are used.

*Injections*—Penicillin has the preference but injections advocated by Ross (1938) give excellent results. a sharp saline purge and 10 c.c. of calcium gluconate intravenously. the local application of hot antiphlogistine and the injection of 1 c.c. of colloidal silver to a depth of 2 cm. into the globus minor with two tablets every four hours of phenacetin  $2\frac{1}{2}$  gr. acetosalicylic acid  $2\frac{1}{2}$  gr. codein  $\frac{1}{2}$  gr. Calcium gluconate preferable to calcium chloride solidifies the intercellular cement substance. assists circulation by dilating capillaries and stimulates phagocytosis. An alternative is the injection of 1 c.c. of the patient's whole blood collected from a vein and inserted to a depth of 1 to 3 cm. into the mass of the swollen epididymis. This may be repeated on the following day if the tension of the tissues subsided within five minutes after the first injection (Beilin 1933). Two or three intravenous injections of mapharside 0.04 gm. every third day also assist resolution.

*Epididymotomy* is indicated when the infection does not subside in three to four weeks or if after apparently subsiding it recurs. A vasotomy should be done at the same time because the seminal vesicles being also infected may cause another attack of epididymitis unless they are treated. Under a general local or spinal anæsthetic the scrotum is incised obliquely for about 2 in. along the junction of the testis and epididymis which is freed from adhesions and punctured with a tenotome wherever pus presents. The abscesses can be irrigated or swabbed out with proflavine 1 per cent. argyrol 20 per cent. or mercury perchloride 1 in 5000. A rubber or gauze drain is left along the sheath of the epididymis for one to three days and the wound sutured.

When infertility has occurred through blockage of the ducts from epididymitis various surgical methods can re-establish contact between the testicle and the efferent ducts by using the coverings of the epididymis as a canal to conduct the semen into the vas (Linde 1937).

*Cystitis*—The mucous membrane of the bladder is so resistant to gonococci that gonorrhœal cystitis is uncommon and when it does occur seldom lasts more than two or three days. It should be suspected when suprapubic tenderness is accompanied by dysuria and frequency and turbidity sometimes with blood occurs in all glasses.

*Pyelitis and Pyelonephritis*—These rarities would be diagnosed more frequently but they have no differentiating characteristics and proof of the gonococcus in the kidney is difficult. They should be suspected if bladder symptoms such as bladder irritability and frequency persist but some cases have a painful pyonephrosis without bladder symptoms.

Destruction of the kidney follows rapidly if the infection continues but Sisk and Wear (1936) obtained rapid recovery with 2 per cent. silver nitrate. Smears and cultures in urine collected from the ureter contain gonococci and the gonococcal fixation reaction may or may not be positive.

*Proctitis*—This common complication seldom causes anxiety. signs and symptoms are absent in most cases. mild in some and only distressing in the very few among the large number of females and those males practising perverted intercourse who become infected rectally. The discharge from



the vagina trickles easily towards the anus but a salve of sulphosalicylic acid 10 per cent rubbed on the anus prevents this. Owing to the abundance of other organisms in the rectum cultures as well as smears should be used for diagnosis and tests of cure but the absence of pus cells is no proof that a gonococcal infection is not present. Cultures from centrifugalized rectal irrigation fluid frequently grow gonococci when they cannot be found in rectal smears. Only 20 per cent of cases present symptoms anal irritation tenesmus pain on defaecation scanty brownish anal discharge inflammation of the anus at the junction of the skin and mucous membrane blood in faeces and abdominal pain. Like urethritis the absence of visible secretion does not exclude the presence of gonococci. Uncommonly rectal and perineal abscesses fistula condylomata acuminata polypi ulceration and stricture occur.

**Treatment**—Masterly inactivity is amply repaid, nearly all cases recover without trouble if the genital seat of infection is cured and the ano rectal condition is left alone. Instrumentation the application of caustics such as silver nitrate and copious irrigations aggravate the condition. Local treatment if considered necessary should be of the mildest type hot baths morning irrigations with boric acid and methylene blue 1 per cent or zinc sulphamate 5 per cent and the nightly insertion of gentian violet jelly trioxar triple dyo jelly sulphonamide paste or suppositories of penicillin glycerine and ichthyol 10 per cent pure glycerine or glycerine and borax.

### TESTS OF CURE

Penicillin and the sulphonamides kill the superficial organisms so that they are less readily detected. Mask symptoms are a potential source of gonorrhoeal carriers and so induce a false feeling of security in both patient and practitioner. Therefore when these drugs are used it is imperative to repeat all the pathological methods of testing (smears cultures and blood reaction) more frequently than was usual before the introduction of the sulphonamides.

**Smears**—These should not be fixed by too much heat or the gonococci will be shrunken into unrecognizable entities. Even when a differentiating stain such as Jensen's modification of Gram is used if reliance is placed on smears alone the percentage of error is over 50 per cent (Mascall 1933). This is increased considerably if methylene blue is used. In both sexes the presence of pus cells without accompanying organisms suggests the gonococcus as the infecting organism in preference to other infections or possibly a chemical rather than a microbial inflammation.

**Cultures**—The tubes containing the special culture media which are innocuous should be warmed at 37.5° C for half an hour before use and returned to the incubator immediately after inoculation. Cultures are more efficient than smears especially if the detection of gonococcal colonies is assisted by the incorporation in the medium of 1 in 30 000 gentian violet (Cox *et al.* 1942) or Nile blue A dye (Gardner 1940) to inhibit the growth of contaminating organisms and by Gordon and McLeod's (1928) oxidase reaction. 1 per cent dimethyl phenylene diamino hydrochloride poured over the surface of the culture turns gonococcal colonies a dark purple and therefore less likely to escape notice but the following organisms also give a positive oxidase reaction—*M. catarrhalis* *M. flavus* *Haemophilus influenza* and an unidentified Gram positive diplo bacillus whose colonies closely resemble those of the gonococcus.

**The gonococcal complement fixation test**—This reaction as valuable in gonorrhoea as the Wassermann test is in syphilis gives a higher percentage of positive results than smears or cultures. It demonstrates the specific gonococcal antibodies in the blood but does not altogether depend on the presence of gonococci in the tissues. Therefore like the Wassermann test, a negative result does not necessarily exclude infection but a positive reaction with the rare exception of cross fixation by *Micrococcus catarrhalis* and *M. flavus* is evidence of a present or past infection. In the first week after



FIG 410

Gonococcal culture. The darkened colonies of gonococci are differentiated by positive oxidase reaction from the whiter growth of other contaminating organisms.

the infecting coitus 27 per cent of cases are positive in the second week 46 per cent and in the third week 70 per cent (Price 1933). The amount of antibody produced depends on the amount of toxin absorbed. This varies with the absorption from the area of infection in both acute and chronic cases. Inefficient drainage aids toxic absorption. Satisfactory drainage prevents this. Antibodies are not formed and the serum reaction remains negative. Consequently infection of the deeper structures the posterior urethra prostate and vesicles the cervical canal uterus and Fallopian tubes is more liable to give a positive result than infection limited to the superficial tissues of the anterior urethra and vulva. The reaction becomes negative after clinical cure in about three months but a positive reaction after apparent cure is an indication to make repeated investigations to detect the hidden

focus from which absorption is taking place. As penicillin can mask and delay a syphilitic infection all cases of recent gonorrhœa who have been treated with penicillin should have their blood reactions tested for syphilis each month for at least three, and preferably six, months before they can be discharged as cured.

**Scheme of testing for cure—IN THE MALE—**Before testing, certain clinical criteria should exist: (1) no discharge, (2) no local or metastatic symptoms, (3) no pus in urine and (4) no abnormalities on palpation of urethra, Cowper's glands, prostate and vesicles.

When these conditions are satisfied the following tests may be performed —

- (a) The passage of an acorn bougie followed by a metal sound into the bladder should detect no obstruction or infiltration of the urethral wall nor provoke any discharge or pus on the instruments.
- (b) Urethroscopy should reveal no soft or hard infiltration, infected follicle or stricture.
- (c) Prostatic and vesicular smears should detect no gonococci and not more than six pus cells per field.
- (d) No gonococci grown on prostatic and vesicular cultures.
- (e) The gonococcal complement fixation reaction should be negative.
- (f) No signs of recurrence following the resumption of normal life: alcohol, coffee and condiments, but no sexual intercourse.

If desirable, additional tests such as silver nitrate (5 gr. to 1 oz.) instilled through an Ultzmann's syringe, dilatation with a Kollmann, or 200 million units of a polyvalent gonococcal vaccine, should fail to provoke a discharge, but these are not to be compared with the accuracy of cultural and serum tests.

**IN THE FEMALE—**If the case obviously responds to penicillin or the sulphonamides when clinical evidence of infection has disappeared, smears and cultures from urethra and cervix should be negative at weekly intervals for three weeks and after that at monthly intervals for three months. But if the effect of treatment is unsatisfactory, urethral, vaginal and cervical smears and cultures, and those from a Bartholin's or Skene's if these existed, should be examined during or after each menstruation for several months. These monthly results, especially the amount of pus in the smears in relation to the number of non-gonococcal organisms, should be compared. When all the tests are negative for at least three consecutive months and the gonococcal fixation test is negative, and the patient has no clinical signs or symptoms, she may be discharged as cured.

### GONORRHOEA IN WOMEN

Frequently symptoms are so vague that unknown to themselves many women may be infected for weeks or months. The insidious chronicity, the high susceptibility to the gonococcus of both sexes, their lack of any true natural immunity and forgetfulness that the wife who has been infected by her husband may also reinfect him, are among the chief reasons for its prevalence.

The urethra and cervix are the commonest and earliest sites of infection which, involving the various anatomical structures on the way, tends to spread up the urinary tract to the kidneys and along the genital passages to the peritoneum. After the acute process has subsided, foci of infection linger in the urethra, cervical glandular tissue, the uterine wall, Bartholin's ducts and glands. Treatment and pathological investigations must be especially directed to these

sites. The general rules and precautions prescribed for the male should be enforced.

**URETHRITIS**—Slight dysuria felt at the beginning of and throughout urination (pain with *B. coli* infections occur at the finish of micturition) and frequency for a few hours are commoner than scalding pain for several days. The urine contains pus threads and may be turbid and acid. Scanty whitish yellow pus exudes from the pouting red oedematous lips of the meatus. The mucosa is inclined to bleed when touched by the diagnostic platinum loop which should be inserted into Skene's tubules and the lacunæ in the floor of the urethra when the discharge is difficult to collect. The finger in the vagina pressing on the urethra sometimes thickened and tender helps a scanty discharge to become visible at the meatus. Most cases heal within ten days with sulphadiazine and alkaline mixtures and without trouble if unnecessary instrumentation is avoided. Although not essential with penicillin or sulphonamide therapy the urethra can be irrigated daily through a Kidd's glass catheter with 1 pint of warm saturated sodium bicarbonate solution followed by 1 pint of

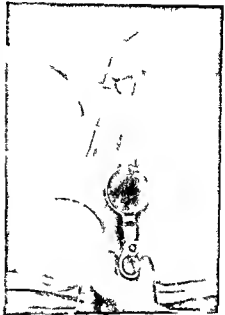


FIG. 411

Collect on of cervical discharge. Culture plate being inoculated with discharge collected by pipette from the cervical canal.

chloramine T and saline potassium permanganate or other suitable antiseptic. In a few *sklenitis* persists and a **PERIURETHRAL ABSCESS** develops in the urethral floor. These should be eradicated by cautery or a silver nitrate probe through a urethral speculum or urethroscope. Retention and strictures requiring graduated dilatation occur in chronic neglected cases but they are uncommon. Polypi and urethral caruncles are common after chronic gonococcal urethritis. They should be removed not by excision or caustics but by surgical diathermy.

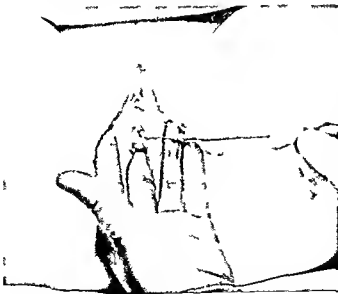


FIG. 41

Collect on of urethral discharge. The platinum loop in urethra collecting discharge expressed by the middle finger in vagina from the urethral ducts.

**CYSTITIS**—This complication rare when purely gonococcal, persists only for a few days and is seldom troublesome. An acid, turbid urine containing pus is accompanied by tenderness or pain over the bladder region, urgent frequency perhaps with terminal hæmaturia, pyrexia and rigors. Cystoscopy reveals an inflamed granular and sometimes ulcerated area, usually localized to the trigone. Against alkaline diuretics and sulphadiazine the cystitis seldom lasts longer than two or three days. Exceptionally, mild antiseptic bladder irrigations and silver nitrate applications through the cystoscope are required.

**VULVITIS AND VAGINITIS**—The patient complains of swelling of the vulva, heat and irritation accentuated by walking. The labia, bathed in discharge from the vagina and urethra, look red and œdematous. The surrounding skin of the thighs and perineum may have a superficial dermatitis from the profuse irritating discharge with the characteristic odour of indole. On separating the labia their inner surfaces and the vagina are so tender, roughened and acutely inflamed that they readily bleed on touch and irregular patches of the velvety mucosa are eroded. The vulval and vaginal tissues, both covered by resistant squamous epithelium, readily throw off the infection after the first few days of acute inflammation.

Hot baths containing dettol, eusol, boric acid or chloramine-T, rapidly reduce the pain and swelling, and vaseline, cold cream or lotio plumbi et opii soothes the irritated skin of the thighs and perineum. Hot and copious vaginal douches boric acid 1 per cent, chloramine-T, eusol, dettol or potassium permanganate, with the addition of 25 drops of tincture of opium per pint if pain is severe, relieve tissue congestion and wash away excessive discharge. Comfort is assisted by inserting gauze between the labia soaked in glycerine, lotio plumbi et opii, calamine lotion or 10 per cent of a soluble sulphonamide in glycerine or in a paste. Penicillin or sulphadiazine should be exhibited as described for males (p. 865), with tincture of hyoscyamus, which possesses a sedative action particularly effective on the female pelvic organs, in an alkaline mixture. When the inflammation is most acute there may be too much pain to insert a speculum but glycerine, which is bactericidal, hygroscopic, non-irritating and odourless, syringed into the vagina aids drainage and the next day the cervix can be examined through a speculum.

**BARTHOLOINITIS**—The orifice of the infected duct shows as a protruding red spot in the furrow between the inner surface of the labium minus and the caruncula myrtiliformis about  $\frac{1}{2}$  in anterior to the fourchette. Pressure on the gland extrudes pus through the duct, which may become blocked by inflammatory congestion and thickening. When this happens, the infected gland is swollen, hot and painful from the pent up pus, the skin becomes red and inflamed, and the *Bartholin's abscess*, which may reach the size of a small egg, points on the inner surface of the labium majus. It seldom bursts into the rectum or in the perineum. On account of the throbbing pain the patient finds it difficult to walk or sit, has malaise and pyrexia, and feels wretchedly miserable. Heat applications are placebos only. The abscess should be aspirated through the mucosa on the inner side of the labium, not through the skin, twice daily for the first two days and once daily after that. The cavity may be washed out with penicillin, a soluble sulphonamide, electargol, saline or proflavine. The torment of packing and subsequent vulval deformity is obviated and, except in exceptional cases, the condition is cured within a week. Only in chronic relapsing abscesses is excision needed, incision is not justified.

**CONDILOMATA ACUMINATA**—These papillomata or venereal warts may appear anywhere on the vulva, especially around the vaginal entrance at the

gauze drain saturated with glycerine and horax (10 per cent) glycerine and ichthyol (5 per cent) glycerine and izal (4 per cent) glycerine and magnesium sulphate or formalin 1 in 300 in glucose (50 per cent) at discretion These are contraindicated in pregnant women and in salpingitis

A convenient routine is a hot vaginal douche each morning irrigation and insertion of gauze drain to be retained during the daytime and a vaginal pessary at bedtime

Suitable pessaries are those containing penicillin sulphonamide pure glycerine glycerine and borax glycerine and boric acid glycerine and ichthyol (10 per cent) glycerine and iodine (1 per cent) glycerine with belladonna and byosecyanus In addition to those usually employed in chronic cases *astringent douches* (all 1 per cent) are useful mercury oxycyanide zinc salts lysol listerine alum picric acid silver nitrate carbolic also *astringent pessaries* glycerine and zinc sulphocarbolate (2 per cent) glycerine and phenol (2 per cent) glycerine and tannic acid (50 per cent) or glycerine and protargol (4 per cent)

For tests of cure see p 876

T ANWYL DAVIES

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## CHAPTER LXXIX

### GENERAL FEATURES OF CALCULOUS DISEASE OF THE URINARY TRACT

#### HISTORICAL

THERE is abundant proof that urinary lithiasis is a disease which is as old as civilization itself. It is from Egypt where so many mummies have been available that the most important evidence of this fact has come.

Hippocrates the Greek (460-370 B.C.) discussed the symptoms and treatment of renal and vesical calculus.

The Hindoos were expert surgeons and they cut for stone using a lateral incision without the aid of a staff. Suprapubic lithotomy was described by them about the beginning of the Christian era.

Celsus the Roman (25 B.C. - A.D. 50) put the operation of lithotomy on a sound basis. The principles he laid down were practised with no important alteration till the sixteenth century. This was an astonishing tribute to the success of his technique. For 2,000 years from the time of Hippocrates cutting for stone by the perineal route was the recognized form of treatment and the old tradition was usually followed that this work should be left to the professional lithotomists.

In Europe from the thirteenth century right on into the eighteenth century cutting for bladder stone was largely in the hands of strolling lithotomists, some of whom were very expert. Frere Jacques towards the end of the seventeenth century was one of the most famous. In 1727 Cheselden of St. Thomas's Hospital put Frere Jacques's operation on a sound anatomical basis. In 1720 John Douglas of Westminster Hospital published his description of the suprapubic operation.

The work of these surgeons sounded the death knell of the strolling lithotomists. Although stone crushing (lithotrity) was introduced by Civiale in Paris in 1818 this operation was not on a sound footing until the second half of the century when the crushing procedure was followed immediately by the evacuation of the fragments (litholapaxy). Surgeons in both the eastern and western hemispheres made successive improvements in the apparatus for litholapaxy which under the names of Sir Henry Thompson of London, Bigelow of Boston and Freyer of London put litholapaxy into the first rank of surgical procedures. This all happened while vesical calculus was still extremely common as a complication of prostatic enlargement and it required the introduction of prostatectomy at the beginning of the present century to establish a new outlook for these cases of vesical calculus. In the latter half of the last century there commenced the gradual alteration in the standard of living which was instrumental in almost stamping out vesical calculus as one of the commonest diseases in children amongst poor people. Towards the end of last century the diagnosis of vesical calculus was greatly assisted by the advent of the cystoscope which overcame the shortcomings of the sound.

The dawn of the anæsthetic era not only proved a boon to both patient and surgeon in dealing with vesical calculus but brought all cases of calculus of the upper urinary tract within the range of surgical aid. This latter field of surgery was made more accurate and successful by the discovery and application of the Röntgen rays. From the latter milestone in medical progress advances have been possible in our time by the discovery of pyelography, first instrumental and later intravenous, which has placed surgery for calculus in the upper urinary tract in the happy position in which we find it to day.

### ÆTIOLOGY

The factors which lead to lithiasis are general in some cases and local in the urinary tract in others. These for the most part are discussed separately under the ætiology of stone, in the kidney and the bladder, where these organs are specially concerned, but there are certain general principles which should be mentioned here.

**Dietetic causes**—Under good living conditions the disease occurs much more commonly in the upper urinary tract than the lower but where the standard of living is bad in certain particulars the disease occurs mostly in the bladder.

The conditions of life which determine the incidence of vesical calculus have largely been determined, they are for the most part dietetic faults (see *Ætiology of Vesical Calculus*). The stone wave which swept Central Europe from 1924 onwards, and resulted in an astonishing increase of stone in the upper urinary tract, is probably dietetic in origin also but the nature of the error has remained obscure.

**Heredity**—Numerous instances have been reported where several generations of the same family have been afflicted. More interesting still are examples where brothers and sisters widely scattered in different parts of the world have all developed calculi.

**Race**—The negro is outstanding in his freedom from lithiasis. This applies to all parts of the world, even when he lives in "stone areas". It has not been shown that any other race enjoys such a degree of immunity, which, however, seems to be lost to some extent where European blood has been mixed with that of the negro.

**Geographical and climatic influences** (see *Food Faults in Relation to Vesical Calculus*)—Having considered dietetic errors it is easy to see how geography and climate can play their part in relation to these. In the so called dry belts of the world such as Northern Africa and the Middle East, stone abounds. Because vegetation is scarce, meat, milk and butter are scanty, but the animals which do exist there depend on green fodder for vitamin A, but as this form of food is only accessible for short periods in the year they have to live largely on straw and husks, hence their flesh and milk are poor in vitamin A. It must be at once clear how these factors are contributory to stone formation, and small wonder it is that lithiasis is common even amongst the animals themselves, and as far as the people are concerned it is obvious that they must depend mostly on cereals for their existence. Water with a high calcium content is important as a stone forming factor where food faults exist.

**Bilharziasis**—In Lower Egypt urinary lithiasis and bilharziasis go hand in hand. But as evidence that the parasitic disease is not the sole cause, we find it prevalent elsewhere especially in other parts of Africa where stone is not often found. The variation in the relationship of bilharziasis to urinary



lithiasis according to locality is doubtless to be explained by the differences in the habits of the people concerned chiefly in relation to diet. The nuclei of stones in association with billiarziasis are not necessarily ova but often debris of inflammatory origin.

**Inflammation**—Painstaking investigations of calculi have shown bacteria to be common in the nuclei of stones (Eisenstadt 1931). The nature of the organisms found has varied with different observers. Staphylococci predominated with some and coliform bacilli with others. Less frequently other bacteria have been reported. Having regard to the fact that the former organisms can split urea and produce ammonium carbonate their presence would seem to be the more important of the two. Other urea splitting organisms such as bacilli of the proteus and pyocyanus groups must be regarded as of equal importance. The evidence all points to the fact that the staphylococcus is the most important organism predisposing to urinary lithiasis. Hellstrom (1936) has described a certain type of calculus as a staphylococcal stone.

**PRIMARY AND SECONDARY CALCULI**—It has been the practice to divide urinary calculi into two main groups primary and secondary. A primary calculus is one which develops independently of any pre existing lesion of the urinary tract. A secondary calculus is one which develops secondarily to a lesion of the urinary tract. Both primary and secondary calculi may arise in the kidney and pass down to the bladder or they may originate in the latter organ. Especially in the light of modern research into the origin of renal calculus this classification is open to the criticism that it is not always certain whether or not the stone is preceded by urinary tract disease. From a practical point of view however the term secondary has a useful application in relation to calculus formation when it obviously results from urinary infection. In the opposite sense the term primary is used to indicate that there is no evidence that a stone has formed in response to an infective process. In the case of secondary calculi the infection causes the urine to decompose with the precipitation of phosphates which deposit themselves round any organic matter—a primary stone or foreign body—which thus forms the nucleus of further calculous deposit. Secondary stones although they commonly originate in the bladder may arise in the kidney as a result of infection there and subsequently pass down to the bladder where they continue to grow.

A mixed primary and secondary calculus results from the deposition of salts from urinary decomposition on a primary calculus.

**Dilatations of the urinary tract**—These are important factors in the causation of stone urinary stasis leading to infection apparently being the precipitating cause. The dilatation may or may not be due to a mechanical obstruction. These facts apply to the upper as well as the lower urinary tract (see *Ætiology of Renal and Vesical Calculus*).

It is the fate of many cases of spinal injury in which the cord is affected to be complicated by chronic retention of urine then to develop infection and ultimately stone even in the upper urinary tract. Mueller (1895) reported bilateral urinary calculus in eight out of ten cases which came to autopsy. Urethral stricture is a cause of dilatation which sometimes gives rise to calculus formation in both the upper and the lower urinary tract.

**Foreign bodies**—In any part of the urinary tract that a foreign body is allowed to remain a calculus is likely to form upon it although the bladder is the commonest site for these they occur on rare occasions in the kidney and even the ureter.

For more detail of ætiology see *Renal and Vesical Calculus* etc.

### THE RELATIVE INCIDENCE OF RENAL AND VESICAL CALCULUS

*Calculous disease occurs at all ages and in both sexes. Any part of the urinary tract may be the seat of stone. The kidneys and the bladder are the localities in which calculi commonly take their origin.*

A study of figures collected by different observers makes it abundantly clear that under modern conditions of civilized life vesical is considerably less common than renal calculus. This state of affairs is in great contrast with what prevailed in former days or indeed with what prevails to day in those countries where the standard of living is still very low for in such circumstances vesical calculus tends to be very common.

The figures of my personal cases of urinary lithiasis amounting in all to 665 show that 19.8 per cent occurred in the bladder 77.2 per cent in the kidneys and ureters and 2.8 per cent in the urethra.

### THE CHARACTERISTICS OF URINARY CALCULI

**Chemical composition**--Urinary stones consist of three distinct parts namely the crystals of the deposited salts the binding material which holds these together the nucleus or central portion around which the stone is formed. This last consists of a piece of organic matter such as inflammatory debris or blood clot or a foreign body. There is a great variety of the cementing elements which are known as colloids. Albumose peptone oxyproteic acid are some of these substances. Their origin is obscure but they are increased in amount in the following circumstances as a result of fasting after taking either protein or a carbohydrate diet and in association with inflammatory processes particularly those affecting the kidneys. It is still a matter of controversy as to what it is that causes the colloid to bind together the crystals to form a stone.

It is likely that the different strata of chemical substances of which a stone is formed are determined by the hydrogen ion concentration of the urine for the time being for example for phosphates to be precipitated the pH must be above 6.9 uric acid is precipitated at 4.9 oxalates and urates at intermediate points between these extremes.

The deposited crystals of which a stone is composed occur in layers which tend to vary in chemical composition. Sometimes one of these substances is present in an outstanding amount. The stones which are formed while *no obvious infection is present*--so called *primary*--may consist almost entirely of either calcium oxalate or uric acid or in rare circumstances of cystine or xanthine or more rarely still of calcium carbonate calcium sodium or potassium urate but these last four substances are generally found in association with calcium oxalate or uric acid. Stones which are deposited as a result of obvious infection (secondary) are the triple phosphates of calcium ammonium and magnesium, the phosphates of ammonium and magnesium. The above varieties are commonly found while ammonium urate and calcium phosphate rarely occur in a pure state but exist frequently in calculi which contain other chemical substances.

**Structure**--This can only be determined by sectioning the calculus with a saw. It then becomes apparent that the stone is built up in a succession of laminae round a central nucleus. The nucleus is often a small portion of organic tissue or a foreign body. In exceptional cases the organic nucleus occupies a considerable bulk of the stone. In vesical calculi blood-clot or debris following fulguration of a papilloma can both produce this state of

affairs Rarely there is more than one nucleus to a calculus. The rest of the stone may be of a homogeneous and granular appearance or it may consist of a series of laminae of different appearance (Fig. 434), in the latter case the stone is obviously of a mixed variety chemically. Cavities and radiating fissures are sometimes seen in the interior of the calculus.

**Colour**—There are variations of the following shades. chocolate, brown, yellow, grey and white

**Weight**—Stones of the same size may manifest considerable differences. These depend upon density, which varies according to chemical composition. Calculi may be arranged in the following order of decreasing weight—calcium oxalate, uric acid, ammonium urate, phosphates

**Consistence**—This also depends on the density. The hardness of a stone is most apparent when lithotomy is carried out. Calcium oxalate stones of a certain size may be very difficult to crush. Uric acid or ammonium urate stones never present this difficulty. Phosphatic stones, if small, may be so soft that they can be crushed between the fingers. For further details of the characteristics of calculi, refer to renal, vesical calculi, etc.

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## CHAPTER LXXX

### CALCULOUS DISEASE OF THE KIDNEYS AND URETERS

SINCE 1920 approximately 45 per cent of the major operations on the kidney performed at St Peter's Hospital were for lithiasis. This figure is much higher than that reported from many of the continental clinics where renal tuberculosis usually takes first place.

#### ÆTIOLOGY—I GENERAL

Much of this subject is discussed elsewhere (see p. 928). I shall only mention points bearing on the formation of renal calculi.

The results of analysis of 276 stones removed from the kidney or ureter in St Peter's Hospital are given in the following table—

Pure calcium oxalate	71
Pure calcium phosphate	81
Mixed (oxalates and phosphates)	101
Carbonates and phosphates	5
Carbonate phosphate oxalate and urate	1
Ammonium magnesium phosphate	1
Cystine	0
Pure uric acid	7

At first sight it would appear that as oxalates and phosphates are present so often they must be held responsible for the great majority of renal calculi. At the same time it must be remembered that these salts are only insoluble when combined with calcium and that calcium entered into the composition of no fewer than 259 out of 276 stones analysed. It would appear therefore that stone is due primarily to a derangement of the calcium metabolism and not to that of the oxalates, phosphates, etc. This is borne out by a study of the calcium metabolism.

**Metabolism of the stone-forming substances—(1) CALCIUM.**—The greater part of our supply of this metal comes from milk which contains 1.4 gm. per litre. Milk products such as butter and cheese and from green vegetables.

Only about a quarter of the ingested calcium is absorbed; the remainder is passed in the faeces. The amount absorbed depends on several factors: (a) *The reaction of the bowel contents.* More calcium is absorbed when they are acid than when they are alkaline. (b) *The amount of phosphate and probably of oxalates in the food.* An excess of these substances produces insoluble calcium salts which are not absorbed. (c) *The nature of the fat in the food.* Calcium is saponified before absorption. If a saturated vegetable fatty acid is in excess an insoluble soap may be formed which is unabsorbable. An unsaturated fatty acid of animal origin produces a soluble soap. This is the reason why butter is much more efficacious than margarine in promoting absorption of calcium. (d) *The calcium intake is influenced in some unknown manner by the presence of vitamin D. When it is absent or present in insufficient*

amounts there is diminished absorption both of calcium and phosphates and the level of these bodies in the blood falls

(2) **OXALATES**—It is usually stated that the average daily output of oxalic acid is from 15 to 20 mg. Recently Barrett (1942) criticized this figure which he considers to be too low.

The exogenous moiety is derived from vegetable foodstuffs. Sorrel, spinach, rhubarb and asparagus contain over 2 gm. of oxalic acid per kg. Tea, coffee, cocoa and pepper also contain large amounts of oxalic acid, up to 4 gm. per kg. but the quantity of these substances ingested is so small that they are relatively harmless. Only a small portion of the oxalates contained in the food is excreted in the urine. The loss has been estimated at 90 per cent. Barrett has thrown an interesting light on this point. He showed that in his human subjects the addition of a dish of rhubarb to a diet low in oxalates raised the elimination of oxalic acid from 30 to 33 mg. to a figure varying from 49 to 67 mg. If on the other hand half a pint of milk or a dose of 0.4 gm. of calcium was taken with the rhubarb there was no increase in the output of oxalates. He concludes that the calcium in the milk combined with the soluble oxalates in the food to form insoluble calcium oxalate which cannot be absorbed.

There must be an endogenous source of urinary oxalates as they persist during starvation or when the animal is fed on an oxalate free diet of milk and sugar. Baldwin in 1902 produced oxaluria in dogs by giving large amounts of sugar over prolonged periods. This Herter suggested might be due to the fermentation products setting up gastritis and reducing the secretion of hydrochloric acid. The metabolism of various proteins, fats and purines has each been held responsible by different authorities for the production of oxalic acid but such theories have not met with general acceptance. A considerable number of oxalate calculi are found in China among individuals who live on a diet which is practically oxalate free. Also Hammarsten succeeded in producing calcium oxalate calculi in rats fed on a diet containing practically no oxalates.

(3) **PHOSPHATES**—It was formerly thought that the urinary phosphates were derived from the inorganic salts in the blood. This is now known to be only partially true. The urinary phosphates are increased when the diet is rich in protein, especially in nucleoprotein and phosphoprotein. Eicholtz and Starling found that the inorganic plasma phosphates were not concentrated in the urine of an isolated kidney perfused by a heart-lung preparation but if organic phosphates were added the urine contained inorganic phosphates in a higher concentration than that in the serum. Removal of the pituitary bodies reduces the urinary phosphates to a minimum. If an organic phosphate is now injected the phosphorus is excreted almost entirely as an inorganic salt.

In dealing with the problem of stone formation one is chiefly concerned with the elimination of calcium. Normally only a very small amount of calcium is eliminated in the urine. According to Cushny the concentration of this metal in the urine is only twice that in the blood. The bowel forms the chief path of excretion. The urinary elimination of calcium can be increased under pathological conditions usually in association with a decalcification of the skeleton.

The urinary elimination of calcium is greatly increased by excessive action of the *parathyroid hormones*. In cases of hyperparathyroidism there is a marked decalcification of the skeleton. The lime liberated from the bones is excreted in the urine and stones form from hypersecretion.

The stones formed under the influence of the parathyroid hormone are composed of calcium phosphate. They have a tendency to be bilateral. As a rule, great stone masses are seen occupying the pelvis and calyces on one or both sides, but occasionally small particles are found in the collecting tubules. These may be large enough to show up on an X ray film, when they appear as minute dots arranged in lines running from a calyx outwards towards the surface of the kidney (Fowweather and Pyrah 1938).

Injuries and diseases of bone are not infrequently forerunners of calculous disease, especially when the patient is immobilized for a considerable period. The primary lesion may be infected or not. It is partly due to local changes at the site of the injury such as the absorption of callous or bony fragments or rarefaction of the diseased bone. There is, in addition, a generalized rarefaction due to decubitus. Thus an abnormal amount of calcium is set free from the skeleton and is eliminated in the urine. In this respect these bone lesions give rise to a condition resembling hyperparathyroidism.

It appears that calcium liberated from the skeleton is of no further use to the organism. This is now generally thought to be the case in hyperparathyroidism, and it is most probable that it holds good for ordinary bone lesions.

Decubitus also acts in another manner. When the patient is lying on his back both pelves and calyces systems are ill drained. The uteropelvic junction is then the highest point of each system. The result is that if small concretions form they cannot escape but are retained in the pelvis or calyces. This point has been investigated at Queen Mary's Hospital for Sick Children, Carshalton. Many of the patients suffering from tuberculosis of the spine, hip or sacro-iliac joints had stones or at least positive X ray findings when admitted into hospital, others developed them during their stay there. The skiagrams showed dense uniform shadows resembling pyelograms filling the pelves and calyces on one or both sides. In many cases the shadows disappeared after the tuberculous lesion was healed, and the child was allowed to run about. These children were nursed as far as possible in the open air and were exposed to direct sunlight. At first it was thought that the stone formation was due to an excess of vitamin D, but it was later found that it could be entirely prevented by (a) putting the patient under shelter for two hours during the hottest part of the day, (b) increasing their allowance of fluid, (c) redesigning the spinal frames so that the patient could be tilted from side to side and also longitudinally, and (d) paying special attention to the cleanliness of their genitalia. With the new frames no patient was allowed to remain for more than two hours in any one position and this was perhaps the most important of all these precautions.

In the case of compound fractures there is the added element of sepsis. This acts in two ways. It increases the amount of rarefaction of the bone involved, and in addition the urinary tract tends to become infected.

Urinary disturbances during pregnancy not infrequently form the starting point of lithiasis. Disturbances during pregnancy are thought to be the starting point of the lithiasis in 15 per cent. of cases.

Diet—Until recently it was assumed that an excess of stone-forming substances in the food was the chief cause of lithiasis. The theory is refuted by an examination of the diet of natives living in the stone districts of Asia. They subsist on a monotonous diet mainly composed of carbohydrates. It is practically purin free and does not contain an excess of oxalates, yet uric acid and oxalate stones are the most common forms of uninfected

**lithiasis** The subject of water is discussed on p 929 in connection with vesical calculi

**HAMMARSTEN'S EXPERIMENTS**—In 1937 Greta Hammarsten published the results of an important series of experiments in which the problem was approached mainly from the angle of the calcium and magnesium metabolism. She was I believe the first to produce calcium oxalate stones experimentally without giving large amounts of oxalates in the food or parenterally. Many of the stones occurred in animals who were on an oxalate free diet but if oxalates were added to the food the stones were larger and more numerous. Out of 204 stones analysed 151 were composed of calcium oxalate 39 of mixed oxalates and phosphates 12 of triple phosphate (infected) 1 of calcium phosphate and 1 of uric acid. Both in their chemical composition and in their distribution these stones closely resemble those of human lithiasis. Infection was rare.

Two diets were used. The first contained small amounts of vitamins A and D but no B or C. The second contained liberal amounts of vitamins A to D. The salt mixture was so arranged that the amounts of calcium, magnesium and phosphorus could be altered easily.

Neither of these diets gave rise to stone formation provided that the supply of calcium and magnesium was adequate and that the reaction of the urine was kept approximately at pH 6. A reduction of the amount of magnesium or of calcium or of both these metals gave rise to stone formation irrespective of the amount of vitamins present. Stones also formed when the reaction of the urine was reduced to pH 5.5 to 5.8. Vitamins appear to have had some effect in preventing stone formation as the calculi were smaller and less numerous when they were present. The addition of oxalates to the food made the stones grow more rapidly.

Hammarsten explains these observations in the following manner. The amount of magnesium in the urine follows rather closely the amount absorbed from the food. Its presence in the urine is entirely beneficial. In the first place it holds the oxalates in solution. In the second it diminishes the amount of the urinary calcium. When magnesium is supplied in adequate amounts most of the calcium is excreted by the bowel.

The metabolism of calcium is more complicated. When the amount in the food is diminished the urinary excretion of this metal is increased and at the same time the animal is in a state of negative calcium balance—that is the output exceeds the intake. It appears that when the amount of calcium ingested is insufficient for the needs of the body, lime is absorbed from the skeleton but the amount absorbed is in excess of the requirements and the excess is eliminated in the urine. One thus encounters the paradoxical phenomenon that when the amount of calcium in the food is at its lowest the amount in the urine is increased and if calcium is given in the food in an easily absorbable form the amount excreted in the urine is diminished. In this case the greater part of the calcium is excreted by the bowel and the calcium balance is maintained.

Hammarsten concludes that three conditions are necessary for the formation of oxalate calculi. They are (1) An increased elimination of calcium in the urine. This is brought about by (a) a deficiency of magnesium in the food (b) a deficiency of absorbable calcium in the diet especially in the absence of fat soluble vitamins and (c) a highly acid diet. (2) A low excretion of magnesium in the urine. This decreases the solubility of calcium oxalate. (3) An excess of oxalates in the urine. This is probably the least important of the three as oxalate calculi can be formed on an oxalate free diet.

Hammarsten is emphatic that nothing is more fundamentally wrong than the belief that calcium should be withheld from the diet of patients suffering from lithiasis.

Greta Hammarsten has gone further than producing stones in her experimental animals. She has succeeded in decalcifying preformed calculi. A series of animals were fed on a diet deficient in vitamins and magnesium until an X-ray examination showed the presence of calculi. The diet was then changed to one rich in all vitamins and also in calcium and magnesium. After two months on this diet the animals were killed, and the post-mortem examination showed complete or almost complete decalcification of the stones. The organic stroma, however, was unaffected and remained in the renal pelvis.

**Randall's theory of calculo-genesis**—Randall (1939) considered that there must be an "initiating lesion" which preceded stone formation and that this lesion must be situated on a renal papilla. In 20 per cent of post-mortem specimens he found small milk white patches situated on the sides of one or more papillae. Microscopic examination showed that they were plaques of calcium salts which were deposited in the interstitial tissues. They were at first covered with epithelium which shut them off from the cavity of the calyx. In this stage they were considered to be harmless.

Later the epithelial covering was destroyed, exposing the plaque to the urine contained in the calyx. When this happened there was a tendency for urinary salts to be deposited on the plaque thus forming a minute primary calculus.

The effect of the plaque is twofold. In the first place it forms a foreign surface on which urinary salts may be deposited, in the second it serves to hold the developing calculus in position. Sooner or later the stone becomes free.

From this discussion it will be seen that there are three main theories to account for stone formation. The first is that it is the result of a vitamin lack, the second is that it is due to a disturbance of the calcium and magnesium metabolism, while the third is Randall's theory. We do not know for certain which of these contains the true cause of lithiasis or, indeed if any of them do. It seems to be most probable that stone is a result of a disturbed mineral metabolism, but much more work must be done before one can accept this hypothesis as proven.

## ÆTIOLOGY—II PERSONAL

**Frequency**—There is little doubt that stone in the upper urinary tract is becoming somewhat more common in this country.

There has been a great "stone wave" over Central Europe since the 1914-18 war. It has been noticed in Germany, Austria, Hungary, and Sweden, and to a less degree in other Scandinavian countries. This "stone wave" assumed formidable proportions. For example, Hellstrom (quoted by Rydgaard 1939) reported a five fold increase in the number of admissions for lithiasis into forty two Swedish hospitals. This enormous increase was almost entirely due to great numbers of cases of small oxalate stones.

Blum (quoted by Rydgaard, 1939) states that this "stone wave" commenced during the years 1923-24. It was not noticed in Germany and Austria during the 1914-18 war, when deficiencies of all kinds were endured but first appeared with a "highly over-vitaminized" diet.

Similar "stone waves" have not been noticed in this country or in the United States of America.



**Distribution**—During the fourteen years 1925-38 (both inclusive) 518 cases of stone in the upper urinary tract were admitted into St. Peter's Hospital. Their distribution was as follows—

Renal calculi (unilateral)	289
Ureteric calculi (unilateral)	133
Stone in kidney and ureter of same side	15
Stone in solitary kidney	10
Bilateral renal calculi	54
Stone in one kidney and opposite ureter	13
Bilateral ureteric calculi	4

**Age**—Stone in the upper urinary tract is a disease of middle age about half the cases occurring between the ages of thirty and fifty. The age of patients suffering from bilateral lithiasis is a little higher than that of patients with unilateral disease. This may be due to the fact that the former usually give a very long clinical history and are really in a late stage of the disease.

Lett found that at the London Hospital 1517 adults and 51 children were admitted suffering from stone in the kidney during the years 1901-34.

**Sex**—Stone in the upper urinary tract is more common in the male than in the female. Lett's figures give the proportion of 1203 males to 898 females or roughly the ratio of 4 to 3.

**Side**—There does not appear to be any marked difference in the frequency in which the sides are affected.

### PATHOLOGY—I THE STONE

The most common type of renal calculus laid down in sterile urine is the crystalline oxalate stone. It is a light brown colour, is dense and hard and is covered with sharp shining crystals. A second variety is the renal equivalent of the mulberry vesical calculus. When it arises in the kidney only the portions not in contact with the pelvic wall are covered with upple-like projections the remaining portions being comparatively smooth. A third variety is the jack stone calculus. It is composed of a small central body from which long thorn-like processes project in every direction. These stones are rare and in my experience only arise in dilated kidneys.

Uric acid and cystine calculi are also formed in sterile urine but are comparatively rare. Their appearance is similar to that of vesical calculi of the same composition but they have a tendency to form casts of the renal pelvis and calyces.

The most common calculi formed in infected urine are the phosphatic. They are a dirty greyish white colour. Their surface is devoid of polish and they are friable. They grow very rapidly—faster than any other form of stone—and soon form casts of the whole pelvo-calycal system.

Stones composed of calcium carbonate are rare although small quantities of this salt are found in many phosphatic calculi. They are white, hard, dense and heavy but these appearances are not sufficient to make a diagnosis without a chemical analysis.

Only one calculus composed of triple phosphate was found in the series tabulated on p. 887. This is surprising as these calculi are not uncommon in the bladder. They have a bluish grey colour and are denser and harder than ordinary phosphatic calculi.

The most common type of stone found in the kidney is the mixed phosphatic and oxalate calculus. It may arise either in sterile or in infected urine.

pressure On section they show distinct lamination and under the microscope they are seen to be composed of fine fibres between which lies an amorphous ground substance They give a rather pale blue with Weigert's fibrin stain Occasionally Gram positive cocci have been found in the outer layers but apparently coliform organisms are never found in sections although they are present in the urine Some have a phosphatic nucleus while in others

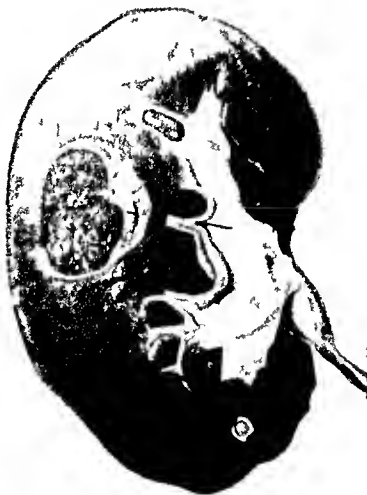


FIG. 414

Hydrocalyx complicated by calculus  
(Ryser quoted by Kennell Watkins)

crystals are scattered throughout the mass They are often associated with ordinary secondary calculi

2 AMYLOID CONCRETIONS—These bodies are occasionally found in the kidneys of patients suffering from amyloid disease They are small rounded masses about 2 to 3 mm in diameter They are a light brown colour have a smooth surface and are somewhat translucent like wax They do not give a blue colour with Weigert's stain but give a strong amyloid reaction with iodine

3 BACTERIAL CALCULI are occasionally found in heavily infected kidneys They are usually small (varying in size from a pea to a small cherry) soft rounded bodies with a smooth polished surface Their colour is grey or

a light yellowish brown and they have a waxy appearance. If numerous they may be faceted from mutual pressure (Fig 413). Stained sections show that they are entirely composed of bacteria which prove on cultivation to belong to the *B. coli* group.

**Development of renal calculi**—The gradual growth of kidney stones can be watched on a series of X ray films. The smallest stone that can be diagnosed by this or any other means lies in the lowest calyx. It gives rise to a small rounded shadow about the size of a pin's head. It may remain in this position for a considerable time gradually increasing in size. Sooner or later it escapes into the renal pelvis but should it fail to do so a dilatation of the affected calyx may result (Fig 414).

When it reaches the renal pelvis there is always a tendency that it will be swept into the upper end of the ureter and if it is small enough it will pass down the canal. If it is retained in the renal pelvis it is at first movable and gives rise to a rounded or oval shadow which slowly increases in size. After a time it becomes impacted at the ureteropelvic junction and is fixed there. When this happens its shape changes. It becomes triangular. One angle projects down the ureter while the remaining angles are directed towards the mouths of the uppermost and lowest calyces. Growth is more rapid at the angles than elsewhere. This is shown by the fact that the crystals at these points are much larger than elsewhere.

During the next stage of development small projections form on the outer side of the stone shadow. They correspond with the mouths of the calyces. At the same time the beak projecting down the ureter becomes more pronounced.

In the fourth stage the calculus forms a complete cast of the pelvo calyx system while in the fifth the kidney is transformed into an enormous stone mass which replaces the greater part of the parenchyma (Fig 415).

Large dendritic calculi are usually composed of calcium phosphate but may be formed of cystine or occasionally of uric acid. Calcium oxalate stones apparently never reach this stage of development. The largest I have seen was triangular each side measuring about 3 cm. The reason for this is that oxalate calculi grow more slowly than any other variety. Giant stones are always composed of substances that are present in the urine in considerable amounts (Joly, 1929).



FIG 415

Enormous renal calculus replacing the greater part of the kidney's substance

When a stone is impacted at the ureteropelvic junction it usually gives rise to a certain amount of obstruction. This has a double effect. It causes dilatation and favours the formation of other stones in the calyces.

**Position**—The following table gives the position of the calculus in 289 cases of unilateral kidney stone observed at St. Peter's Hospital —

Renal pelvis alone (usually single)	130
Multiple calculi, pelvis and calyces	61
Dendritic	40
Uppermost calyx alone	7
Middle calyx alone	5
Lowest calyx alone	37
Position not stated	9

From this it will be seen that most calculi are contained either entirely or partially in the renal pelvis, and that when they lie in the calyces the lowest calyx is by far the most common site.

**Ureteric calculi**—The position of the stone in 133 cases observed at St. Peter's Hospital was as follows —

Lumbar portion	23
Iliac portion	4
Pelvic portion	86
Intramural portion	18
Position not stated	2

These figures agree with those obtained from other sources, and show that most ureteric calculi become impacted below the brim of the pelvis.

Most ureteric calculi are shaped like a date stone or an almond, and rarely exceed 1 in. in length. Even the largest of them are small when compared with giant renal calculi.

Infection is more common in renal than in ureteric calculi. It occurred in 53.1 per cent. of the former and in 39.5 per cent. of the latter. About half of all unilateral stones in the upper urinary tract are infected. In bilateral lithiasis infection is much more common. It was present in 72 per cent. of the cases from St. Peter's Hospital.

There is little doubt that all forms of infection facilitate stone formation, as pus and epithelial cells form a nucleus on which urinary salts may be deposited. In addition many organisms, such as staphylococci and *B. proteus* render the urine alkaline and so favour the deposition of phosphates and carbonates.

Hellstrom (1936) has done much valuable work on what he calls "staphylococcus stones." He dissolved the inorganic portions of calculi in hydrochloric acid and took smears from the gelatinous matrix. In many instances cocci were found in all layers of the stone. In other cases he embedded the organic stroma and sectioned it. Cocci were found lying in concentric layers. He was also able to cultivate organisms from the central portions of these calculi. In most instances the calculi were composed of calcium carbonate, triple phosphate and amorphous phosphates.

## PATHOLOGY.—II THE KIDNEY

**Aseptic lesions**—Any stone lodged in the renal pelvis gives rise to catarrh and excoriations of the mucous membrane. This is followed by a round cell infiltration of the pelvic wall, which in turn causes an increased fibrosis. The



FIG 416  
A sectioned kidney showing both carcinoma and stone  
(*Sir Gordon Gordon Taylor's case*)

The second variety is the giant form. The kidney is transformed into an enormous pus-filled sac while a small stone blocks the upper orifice of the ureter. Externally the kidney preserves its reniform shape but its surface is covered by low rounded elevations corresponding to the greatly dilated calyces. On section the renal pelvis is only slightly increased in size and contains a small calculus. The calyces on the other hand are enormously dilated and are transformed into cyst-like cavities often a couple of inches in diameter. They are separated from each other by thin partitions the remains of the columns of Bertin. The renal parenchyma is reduced to a thin sheet not more than a few millimetres in thickness. In places it may appear to be entirely destroyed and the mucosa of the calyx is in direct contact with the fibrous capsule which is always thickened. The perinephric fat is increased in amount in the region of the renal pelvis but may be thin over the greater part of the organ.

The third variety is the atrophic form. The kidney may be no larger than a walnut and is extensively hollowed out so that the remaining parenchyma is reduced to a negligible amount. The renal pelvis is dilated and contains one or more stones. The kidney is usually enclosed in a great mass of fibrous fatty tissue which may be mistaken for an enlarged kidney. This form of calculous pyonephrosis is distinctly rare.

Changes produced by ureteric calculi.—A stone impacted in the ureter gives rise to a much greater degree of obstruction than one in the renal pelvis. Even when the calculus is small and has only recently become impacted the ureter above it may be considerably dilated and angulated. The renal pelvis is also dilated and all the calyces are distinctly clubbed. These changes tend to regress once the obstructing stone has been removed and in a pyelogram taken some months later the only noticeable change is a slight degree of clubbing of the calyces. In these cases there is little alteration in the ureteric wall except that the muscular tissue is hypertrophied. This explains the rapid return to normal after operation.

The presence of infection aggravates the condition. The ureter tends to be more dilated and marked inflammatory changes take place in its wall. It becomes much more fibrous and is transformed into a thick-walled melastotic tube which remains dilated after removal of the stone. These changes tend

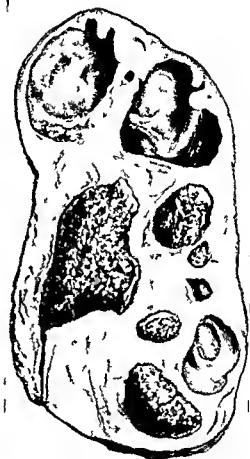


FIG. 417

Pyonephrotic kidney with extensive fatty infiltration of the parenchyma. A mixture of the *staphylococcus aureus* and a non-haemolytic *streptococcus* was found in the urine.

The first comprises symptoms due to a fall in blood pressure the facies is drawn and anxious, the skin is pale and covered with cold sweat the extremities are cold, the pulse is small thready and rapid

The second group is composed of symptoms referred to the gastro intestinal tract Nausea and vomiting are exceedingly common Constipation accompanied by flatulent distension of the bowels is also frequently present Much less common is rectal tenesmus with the passage of small watery stools These symptoms are usually associated with a certain amount of rigidity of the abdominal muscles In most instances it is slight and is confined to the oblique muscles of the affected side If the pain is diffuse and accompanied by abdominal distension the whole abdomen may be more or less rigid but it never presents the board like rigidity found in cases of perforation

Reflex symptoms may be connected with the urinary organs There is usually increased frequency of micturition which becomes more marked as the stone approaches the bladder When it reaches the intramural portion there is definite vesical tenesmus and at the same time pain is felt at the tip of the penis during micturition The amount of urine excreted may be considerably reduced but complete anuria is quite exceptional As soon as the pain ceases a compensatory polyuria sets in

A renal colic usually lasts for a few hours Occasionally it may continue in a subacute form for several days As a rule the patient demands relief from his intense pain and is given an injection of morphia or some other sedative He falls asleep under the influence of the drug and when he awakens the pain has ceased

The termination may be sudden or gradual When it is sudden the patient feels "as if something had given way within him" and the pain ceases immediately This means that the stone has passed into his bladder from which it is usually eliminated within the course of a few days When the colic ends gradually, the spasm of the ureter slowly relaxes and urine commences to trickle past the stone This reduces the pressure within the renal pelvis and relieves the pain A gradual termination is not so satisfactory for the patient as the stone remains in the ureter and will sooner or later give rise to another colic The interval may only be a few hours or may be as long as several weeks There may be several attacks of pain before the stone is passed into the bladder

A renal colic which ends suddenly with the expulsion of the calculus is called "complete" one in which the pain dies away gradually without elimination of the stone is called "incomplete"

The amount of urine passed during an attack is usually small An almost complete anuria is very uncommon If it occurs one should suspect that the kidney on the painful side is the only functioning organ but anuria has been noticed when the opposite kidney is capable of excretion The condition is then usually ascribed to a reflex inhibition but it can equally well be put down to a marked fall in blood pressure The urine usually contains a little blood The amount is just sufficient to render it smoky and this change may not be noticed by the patient Hæmaturia is an important sign as it generally indicates that the pain is renal in origin It is absent in most intra abdominal conditions

The DIFFERENTIAL DIAGNOSIS is frequently difficult A right sided renal colic may be confused with an appendicitis or a biliary colic while one on either side may be diagnosed as an acute intestinal obstruction

In acute appendicitis the pain is most severe over McBurney's point Muscular rigidity is marked and chiefly involves the lower lateral quadrant Tenderness in the loin is rare The pulse is more rapid and the constitutional symptoms are more severe than in a renal colic

In biliary colic the pain is most intense anteriorly and tends to radiate towards the shoulder. Muscular rigidity is more marked anteriorly, as the upper part of the right rectus is rigid. Pressure in the costo vertebral angle is not painful. Jaundice may be present. The urine does not contain blood.

If the colic is accompanied by diffuse tenderness over the whole abdomen with flatulent distension of the bowels an acute intestinal obstruction may be suspected. The pain of a colic however precedes the distension, while in intestinal obstruction distension is the first symptom. Muscular rigidity is much more marked and extensive in acute obstruction and there is little or no loin tenderness. The presence of blood in the urine and the fact that the constitutional symptoms are not unusually severe are both points in favour of a renal colic.

If the surgeon is in genuine doubt whether he is dealing with a renal colic or an acute abdomen, it is far safer to do a laparotomy than to try expectant treatment. A quick decision is necessary as, if the pain is due to a colic morphia should not be withheld while in acute intra-peritoneal lesions it is contra-indicated before operation. I have seen two cases in which the abdomen was opened during a renal colic. In both the stone was found and removed, so the patient did not suffer from the diagnostic error.

**TREATMENT OF RENAL COLIC** has two objects. To relieve the pain and to favour the expulsion of the stone.

Morphia is usually given to relieve the pain, but it is comparatively inefficient. Macht (1916) showed that alkaloids of the morphia and codein group increase the tone of the ureter, while papaverin and narcotin relax it and that in preparations containing the total opium alkaloids the action of the latter group predominates. For this reason opium or omnopon is preferable. If morphia is given it should be combined with atropine, as the latter drug tends to counteract the increased tone produced by morphia. Physeptone (Burroughs Wellcome & Co.) 10 mg intravenously, has been known to stop an attack of colic instantly.

Instrumental treatment is rarely possible during an acute attack. In subacute attacks the passage of a ureteric catheter above the stone at once relieves the pain but one cannot say beforehand if it is possible to insinuate the instrument above the calculus. If this method is tried a dose of opium or omnopon should be given half an hour beforehand. Either a rather large and stiff catheter or else a thin flexible one should be passed. The first instrument displaces the stone upwards while the second may slip past it. In either case the obstruction is relieved and the pain ceases. About 10 to 15 drops of sterile liquid paraffin should then be injected to lubricate the ureter and facilitate the descent of the stone. This treatment may only give temporary relief as the stone may become impacted again.

**Symptoms of an uninfected renal calculus**—The most important of these are pain and hæmaturia.

**PAIN**—About 17 per cent of patients give a history of a complete renal colic. This may have happened several years previously, or may even have been on the opposite side. One often finds that several attacks of severe pain without the elimination of a calculus have been experienced in the past, but that more recently the pain has lost its paroxysmal character and become more or less constant.

The acute paroxysmal pain usually occurs when the stone is movable and is an early symptom. It was noticed in 38 per cent of the cases at St Peter's Hospital. It is caused by a sudden occlusion of the upper end of the ureter, when the stone is swept against it. The stone acts as a ball valve and



spasm of the ureter completes the obstruction. As soon as the stone moves the obstruction is relieved and the pain ceases.

The most common and typical pain of an uninfected renal calculus is a dull fixed pain in the loin. At first it may alternate with the acute paroxysms but it tends to become more marled after they have ceased. It was noted in 62 per cent of the cases from St Peter's Hospital. It occurs when the stone is impacted in the renal pelvis and is therefore a comparatively late sign. The pain is definitely increased by exercise or jolting and relieved by rest. It is usually described as a dull ache or a boring pain. After exercise it is much more severe and described as stabbing or cutting. Many patients complain that it is worst in the evening after the day's work. It is usually felt in the angle between the last rib and the erector spinae but when severe it may spread to the front of the abdomen. It shows little tendency to radiate downwards to the groin. When severe it is accompanied by loin tenderness.

A few cases have been described in which the symptoms were said to be referred to the opposite kidney. If the pain is severe it may spread across the middle line. It is then felt on both sides.

**HÆMATURIA**—Next to pain this is the most important symptom. A hæmaturia of sufficient intensity to be noticed by the patient was present in 44 per cent of the patients treated at St Peter's Hospital. It varies with the amount of the pain being most intense when the pain is most severe. This means that it is most noticeable after exercise or jolting. As a rule the amount of blood found in the urine is not large and is only sufficient to render it smoky. A profuse hæmaturia is quite exceptional. Blood clots are also uncommon; if they are found they are small and resemble tea leaves. Long ureteric clots are very seldom present. Occasionally one may be found after a severe bout of pain.

**Symptoms of infected renal calculus—PAIN**—In about 16 per cent of cases one obtains a history of one or more attacks of renal colic often followed by the passage of a stone. They may have occurred many years previously possibly before the kidney became infected.

Once infection has set in the pain diminishes in severity. About 11 per cent of patients state that they never had pain in the affected kidney while most of the remainder only admit a slight ache or feeling of discomfort in the loin. On the other hand severe pain is experienced in about 30 per cent of infected cases. It is then due to a pyonephrosis, a perinephric abscess or to sudden occlusion of the ureter by a pelvic stone. In these conditions the pain is usually accompanied by a sharp rise of temperature.

**PYURIA**—Pus is found in the urine in every case of infected renal calculus. If the amount is large the patient may notice that he is passing thick urine; if it is small pus cells may only be found on microscopic examination.

A gross symptomless pyuria is often the sole sign of infected lithiasis and not infrequently is associated with giant calculi.

The pyuria may be intermittent. In such cases the ureter becomes blocked from time to time. When this happens the urine clears but the pain in the loin is increased and the temperature tends to rise. As soon as the obstruction is relieved the urine becomes loaded with pus but the pain and temperature both subside.

**HÆMATURIA**—A gross hæmaturia was found in 32 per cent of the cases from St Peter's Hospital. In most instances it was a comparatively early symptom. In cases of severe infection a macroscopic hæmaturia is uncommon. The same applies to the finding of red blood cells in the urinary sediment but it is possible that they are hidden from view by the enormous number of pus cells present.

**STATE OF THE GENERAL HEALTH**—Every patient who harbours an infected renal calculus must suffer from a certain amount of septic absorption. Sooner or later this undermines his general health. He loses weight and becomes easily fatigued. His appetite is poor, his tongue is coated, and as a rule he is constipated. He becomes pale and a blood count shows that he is suffering from a secondary anaemia. At the same time there is usually a distinct leucocytosis. Perhaps the most remarkable feature of these cases is the rapid improvement that takes place after an operation which eradicates the sepsis.

A certain amount of fever is often present. The most common type is a slight evening rise which may not be noticed by the patient or even by his doctor. The evening temperature is usually between 99 degrees and 100 degrees. In the morning it is normal. In spite of this slight degree of fever the patient feels comparatively well and is able to carry out his normal duties.

In cases of pyonephrosis or perinephric abscess one usually finds that the patient has a temperature of the "septic type." It rises to 101 degrees or perhaps 102 degrees at night but in the morning it is approximately normal. Rigors are rare but the constitutional symptoms are severe and the patient is unable to work.

The most serious form of fever occurs when an acutely inflamed kidney becomes blocked by a stone at the ureteropelvic junction. This usually gives rise to an attack of acute pain, and during it there is a rigor with the temperature rapidly rising to 103 degrees or 104 degrees. As long as the pain continues the temperature remains at this high level and the rigors may be repeated. Once the stone is disimpacted the temperature rapidly falls. If this does not happen within a short time an emergency operation may be necessary in order to remove the obstructing calculus.

Occasionally if the infection is only slight, an acute attack of pain may be accompanied by a rigor and a sudden rise of temperature. The rigor is, however, not repeated, the temperature quickly becomes normal, and after a few hours the patient feels no further ill effects.

**Symptoms of a stone in the ureter**—If the calculus passes slowly down the ureter it gives rise to a series of painful attacks. They are usually shorter and less severe than a complete colic but their intensity may vary. The interval between these attacks is very variable. It may be only a few days or hours or may be as long as several weeks. The most characteristic feature of these crises is the gradual change in position of the point of maximum pain. When the stone lies just below the renal pelvis the pain is most intense posteriorly. When it is in the lowest third of the lumbar ureter the pain is chiefly referred to a point about two inches lateral to the umbilicus. A stone deep in the pelvis gives rise to pain a short distance internal to McBurney's point, while one in the intramural portion is accompanied by pain over the external abdominal ring. In all these attacks the pain tends to radiate downwards so that the point of maximum intensity marks the upper limit of the painful area.

**IMPACTED URETERIC CALCULUS**—*Pain*—About 60 per cent of patients give a history of one or more attacks of renal colic which are frequently followed by the passage of a stone. When the calculus becomes impacted they give place to a dull fixed pain, increased by exercise and relieved by rest. The position of this pain depends on the site of impaction, and is similar to that described in the preceding paragraph. Most calculi are impacted in the pelvic portion and give rise to pain near McBurney's point. This is a frequent source of diagnostic error. Pain of this nature is often associated with a renal hæmaturia due to back pressure.

The intensity of this pain is very variable. It may be very severe but is usually only a dull ache. It is uncommon to find complete absence of pain.

**HÆMATURIA**—Occasionally the hæmaturia is very profuse but as a rule it is only sufficient to render the urine smoky. It does not seem to be influenced to any great extent by exercise.

In the absence of a gross hæmaturia the urine usually contains a few red blood cells.

**CHANGES IN THE QUANTITY OF URINE** eliminated are not uncommon. A ureteric calculus is frequently associated with a unilateral polyuria. On cystoscopy the efflux from the affected side is much more frequent and copious than that from the opposite ureter. A total polyuria may occasionally be present. An oliguria is more common. In most instances it is slight but occasionally complete anuria may be noted. It should be remembered that calculous anuria is much more common in cases of ureteric than of renal lithiasis.

**SYMPTOMS REFERRED TO OTHER ORGANS**—Occasionally a stone lodged in the pelvic ureter may give rise to symptoms referred to the genital tract. They are painful nocturnal emissions, pain on ejaculation often accompanied by the passage of blood stained semen, pain along the course of the vas or in the testicle. Young (1907) considers that they are due to irritation of the seminal vesicle by a stone in its vicinity.

Pain in the rectum is occasionally noted. It may be confined to the side on which the stone lies. Vesical symptoms are more common but are practically confined to cases in which the stone lies in the intramural portion of the ureter. They are diurnal and nocturnal frequency of micturition and pain at the tip of the penis at the end of the act.

## EXAMINATION

**Physical examination**—It is always difficult to feel the kidney during an acute attack of pain as it is masked by the rigidity of the flank muscles. At the same time pressure on the loin is always painful.

In cases of uninfected renal calculus the kidney is seldom much enlarged and appears to be normal to the examining fingers. It is usually tender especially when there is a renal ache at the time the examination is made. Tenderness over a point about two inches lateral to the umbilicus is frequently found when a calculus is impacted at the upper extremity of the ureter.

*The changes found in infected lithiasis are much more striking.* The kidney may be an immense pyonephrotic sac filling half the abdomen or a shrunken atrophic organ not much larger than a walnut. In most instances it is moderately enlarged and lies at a lower level than usual so that palpation is easy. It is movable both in a vertical and a horizontal direction. Its surface is smooth but there may be a few low rounded projections on it. The kidney is usually tender.

A large pyonephrosis gives rise to a tense oval swelling which fills up the loin and bulges the abdominal wall forwards. It is not freely movable as it is usually held in position by pressure of the abdominal muscles. Palpation is painful and increases the contraction of the abdominal muscles. Fluctuation can occasionally be made out.

A ureteric calculus is very rarely palpable through the abdominal wall but may be felt on rectal or vaginal examination.

**Cystoscopy**—IN CASES OF UNINFECTED RENAL CALCULUS there is usually no change in the appearance of the bladder wall or the ureteric orifice. There

may, however, be a change in the nature of the efflux. In early cases it is often more frequent and forcible than that on the opposite side. This is due to a unilateral diuresis. If the kidney is in a state of partial retention the efflux may be infrequent and lack force. A turbid efflux is usually due to blood in the urine.

IF THE KIDNEY IS INFECTED the ureteric orifice is more or less oedematous and congested. At first its movement is unimpaired, but as the kidney is increasingly damaged the orifice gradually becomes dilated and rigid. The efflux is always turbid unless the amount of pus in the urine is too small to be recognized by the naked eye. It may be frequent and vigorous at first, but as the renal function diminishes it becomes more and more infrequent. If the kidney is pyonephrotic the efflux is often very infrequent, but when it

does occur it is exceedingly copious. When the kidney is completely destroyed the efflux may consist of thick pus which slowly exudes from the ureteric orifice like tooth-paste from a collapsible tube.

**URETERIC CALCULUS**—A few days after a renal colic, small flame shaped submucous hæmorrhages may be seen close to the ureteric orifice. They are most numerous on its upper and outer aspect. There is always a narrow clear space between the hæmorrhagic area and the orifice itself. These hæmorrhages at first show up as bright red patches, later they become purple and as they fade away they assume a brownish tinge. They are most common when a stone is impacted somewhere in the course of the ureter but very occasionally they are found when it lies in the renal pelvis. Exceptionally they are found in non calculous conditions *e.g.* neoplasm.

When a stone is impacted in the upper part of the ureter the cystoscopic appearances are similar to those of a renal calculus. As it nears the bladder

the ureteric orifice becomes oedematous and is also dilated. The most marked changes are observed when it reaches the intramural portion. The orifice is dilated oedematous and congested. It is a dusky colour and may show irregular patches of submucous hæmorrhage and has an irregular surface. The orifice is seen to contract violently and soon the tip of the stone appears. It is gradually extruded and finally falls down on to the base of the bladder. When there is no infection the stone has usually a brown colour and the surrounding mucous membrane has a dusky hue. The presence of infection increases the contrast. The stone is then white from a covering of phosphates, while the mucosa round the orifice is greatly swollen and plum-coloured.

**Radiography**—Practically every stone in the upper urinary tract is diagnosed by means of an X ray examination. It is important, therefore that this examination should be made whenever the patient complains of acute or chronic loin pain or suffers from an unexplained hæmaturia or pyuria.



FIG 418

A transparent renal calculus shown up by pyelography. It appears as a light oval area within the shadow thrown by opaque fluid in the pelvis. (Mr. Ogier Ward's case.)

The opacity of a stone depends other things being equal on its chemical composition. The most opaque calculi are those composed of calcium oxalate phosphates and carbonates. There is little to choose between the opacity of these substances and stones composed of them throw deep X ray shadows. Uric acid calculi have the same density as the soft tissues of the body and are not visualized on a plain film. Stones composed of urates generally throw a faint but distinct shadow while those composed of cystine are fairly opaque but the shadows they throw are never as dense as those cast by calculi composed of lime salts. Transparent calculi are usually formed of uric acid but in a few instances may be composed of opaque substances. I have seen one instance in which stones formed of a mixture of oxalates carbonates and phosphates failed to give any shadow on a plain film but in



FIG. 419

Rad.ograms of a large renal calculus. Left, antero posterior view. Right, lateral view. The stone shadow is projected on the anterior position of the shadows of the bodies of the vertebrae.

this case the calculi were unusually light and porous. The presence of transparent calculi can usually be demonstrated by pyelography when they appear as filling defects in the shadow cast by the opaque medium (Fig. 418).

**THE SHADOWS OF RENAL CALCULI** are usually uniform. Occasionally they show distinct lamination. Stone shadows are never mottled like those of calcified glands; they have sharply defined edges.

A stone shadow either lies entirely within the kidney shadow or else on its inner border. The shadow of a stone in the renal pelvis lies in the clear space between the psoas shadow and that of the kidney itself at the level of the sinus notch. When the stone is small the shadow is round or oval but as it grows it tends to become triangular (Fig. 419).

A stone in the lowest calyx throws a shadow which lies in the lowest third of the renal shadow. It is usually about half an inch from the lower pole. If the shadow is small it is usually round or oval. When it becomes larger it may assume the shape of a collar stud. A stone in the middle calyx lies about half an inch from the outer border of the kidney at the level of the renal notch. A stone in the upper calyx gives a shadow which is entirely above the last rib. It is distinctly rare to find solitary calculi in this position.

**THE SHADOWS OF URETERIC CALCULI**—Stones impacted in the ureter throw shadows that are comparable with those of renal calculi. Their outline is sharp and their density is generally uniform. If lamination is noticed it is usually confined to the lower portion of the shadow. These stones are usually round or oval when they first leave the kidney but if they remain for long in the ureter they tend to become cylindrical or almond shaped (Fig 420).

The ureter can easily become displaced from its normal position and when it is dilated and angulated the shadow of a stone in it may lie a considerable distance from the usual line.

A stone in the lumbar ureter usually lies with its long axis vertical and if this line is prolonged it should cut through the transverse processes of the vertebrae above and below it. The long axis of a stone in the upper part of the pelvis is directed from below upwards and inwards that of a calculus opposite the spine of the ischium is again vertical while if it lies below this point its axis is inclined upwards and outwards. If multiple calculi are present a line drawn through them should correspond with the line of the ureter.

In most instances an intravenous pyelogram gives all the necessary information (Fig 421). This is specially the case when the bladder urine is sterile. It is then rare to find that the functional activity of the diseased kidney is totally abolished so that good excretion may be expected from both sides. In such cases any diminution in the function on the affected side can be determined by a delay in the appearance of the pyelographic shadow or a delay in the elimination of indigo carmine.

If the bladder urine is infected one must determine whether the non-calculous kidney is also infected. This usually necessitates catheterization of the ureters. If catheters have been passed there is no reason why a retrograde pyelogram should not be made provided that a good specimen of urine has been obtained from both sides. This precaution rules out cases of pyonephrosis in which an ascending pyelogram may be dangerous. The only other precaution is that as much of the opaque fluid as possible should be sucked out after the examination.

The stone shadow is always completely included within the shadow of the opaque fluid. As most calculi give rise to a certain amount of obstruction the shadow obtained by intravenous pyelography is usually deep and distinct that appearing on the healthy side is often much fainter as the opaque fluid passes without hindrance into the bladder. Thus a faint shadow may indicate that the kidney is active and unobstructed but it must be remembered that as a result of a recently impacted stone in the ureter there is often no sign on the urogram of functional activity of the corresponding kidney.

Formerly much discussion was centred on the diagnosis of conditions which gave rise to *false shadows*. They were due to opaque bodies in or near the kidney which gave rise to shadows which were confused with those of true calculi. Now most of them can be excluded by an intravenous pyelogram.

The most common renal conditions giving rise to false shadows are areas of calcification in tuberculous kidneys or in new growths of the organ caseous masses or occasionally parenchymal stones. Areas of calcification throw sharp shadows which are extremely irregular and this is sufficient to distinguish them from stone shadows. Caseous masses usually throw a faint uniform shadow with ill defined edges they are not included in the pyelogram. A parenchymal stone gives a shadow which resembles a stone shadow in that it is dense uniform and has well defined edges but which is distinct



FIG 420

Radiogram of a stone in the lower end of the right ureter. The nucleus is plainly visible and appears to lie in the middle of the stone. The nucleus is really at the junction of the middle and lowest thirds. The radiogram shows that the stone is foreshortened so that the upper portion is not seen. Radiogram taken obliquely.



FIG 421

Radiogram of two stones in the renal pelvis. Note the relationship to the kidney shadow. Right: pyelogram of same case, the stones show up as light areas in the shadow of the opaque fluid. The narrowing of the upper point of the ureteric shadow is due to spasm of the ureter and is nearly always present when a stone is impacted in the renal pelvis.

from the pyelogram. Its position within the kidney is determined by exposures taken on inspiration and expiration (Fig. 422).

**Pelvic shadows** are usually due to phleboliths or to areas of calcification in the sacro sciatic ligaments. They are round or oval, dense, sharply defined and are usually about 3 to 5 mm in diameter. Their usual position is close to the pelvic brim below the level of the spine of the ischium. This is below and outside the line of the ureter and this is generally sufficient to distinguish them from ureteric calculi. In doubtful cases the diagnosis can be made by pyelography. These shadows are very common. Thurstan Holland states that they are present in one out of every 3.4 male and in one out of every 4 female cases (Fig. 423).

### COURSE AND TERMINATION

A stone in the upper urinary tract is always a serious condition for the patient. At best he may eliminate it after one or more attacks of renal colic. In most cases an operation becomes necessary. It may be a comparatively minor affair, such as dilating the ureter or incising its vesical orifice, or it may involve exposure of the kidney or some portion of the ureter. In either case there is always a risk of recurrence.

The advent of infection greatly aggravates the patient's condition. Unless it can be cured he is liable to rapid recurrences after operation, and ultimately dies from sepsis and renal failure. There are three degrees of infection. In the first the infection is confined to the side on which the stone lies. In the second a unilateral lithiasis is combined with a bilateral infection. In the third, infected calculi are found on both sides.

If the infection is not cured, the state of the patient is extremely precarious. Many may live for twenty years in spite of a bilateral infection but very few live for much longer. They gradually go downhill and ultimately die of uræmia. As stone usually affects patients between the ages of thirty and fifty, the expectation of life is seriously diminished.

### TREATMENT

The treatment of urinary lithiasis is both medical and surgical. The aim of medical treatment is to facilitate the elimination of the calculus, to prevent a recurrence, and to cure infection. Surgical treatment consists in removing any calculus that may be too large to be eliminated naturally, in correcting any anomalies in the urinary passages that may give rise to stagnation and secondary stone formation and in removing functionless kidneys. Thus it will be seen that after an operation for stone the patient should be put on a course of medical treatment, and that the removal of a calculus is not sufficient to relieve his tendency towards lithiasis.

**Medical treatment**—Up to the present the medical treatment of calculous disease has mainly consisted in forbidding food which contains, or gives rise to stone forming salts and it must be confessed that this line of treatment has proved to be singularly inefficacious.

At the same time, if a patient is known to suffer from lithiasis, the salts of which his calculi are composed should be restricted. This will slow down the rate of growth of the stones but will not prevent their formation. Thus if a patient suffers from uric acid lithiasis the intake of purins should be cut down, while if his stones are composed of calcium oxalate the consumption of vegetables and fruits rich in oxalates should be restricted.



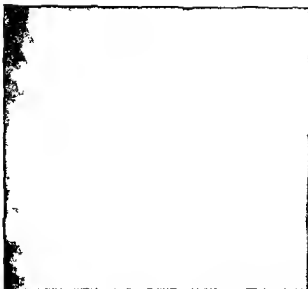


FIG 422

Radiogram of a large pelvic calculus with a small doubtful shadow to its outer side. The small shadow was shown to be thrown by a stone by the fact that the relationship of the two shadows was the same in the radiograms taken on inspiration and expiration.



FIG 423

A radiogram showing a large number of pelvic shadows. Note the clear sharp round or oval shadows lying close to that of the pelvic brim. They are usually found below and outside the line of the ureter. In stereoscopic radiograms they appear to lie on the posterior wall of the true pelvis.

The influence of the calcium and magnesium metabolism on *oxalate lithiasis* has been described (see p 888). The value of milk appears to be twofold—it provides a good supply of vitamin A and also adequate amounts of calcium in an easily absorbable form.

*Phosphatic lithiasis* is nearly always due to sepsis. It is impossible to cure the infection until the stone has been removed, but as soon as this has been done a course of sulphathiazole or of some other drug of the sulphonamide group should be given.

The medical treatment of *cystine lithiasis* gives good results. Cystine or its parent cysteine can be obtained from all complete proteins on hydrolysis but is present only in small quantities in caseinogen and egg albumin. These are the only proteins that may be given with impunity. All forms of meat and fish are forbidden. Carbohydrates and fats are unrestricted. Cystine crystals are soluble in alkaline media but not in acid. The urine should therefore be kept permanently alkaline. It may be necessary to give as much as 120 gr a day of sodium bicarbonate to effect this. The patient should test his urine with litmus paper every morning and evening and regulate his dose of alkali accordingly.

In all forms of lithiasis the patient should drink enough bland fluid to bring the urinary output up to 70 to 100 oz (2 to 3 litres) a day. This reduces the concentration of the stone-forming salts to one half and at the same time provides a sufficiently strong urinary stream to wash out small stones or crystals.

**Surgical treatment of renal calculus—INDICATIONS—**Any stone that is too large to be eliminated naturally ought to be removed surgically. There is no doubt that the best immediate and remote results are obtained by an early operation. The urinary tract is then uninfected as a rule and the stone is small enough to be removed through an incision in the wall of the renal pelvis. The indications for operation therefore depend largely on whether the stone can be eliminated naturally or not.

A small stone usually throws an X-ray shadow which is round or oval. If the diameter of this shadow is more than a centimetre operation should be advised, as there is no possibility that the calculus can be passed. If the diameter of the shadow is less than 5 mm one should wait, as it is probable that the stone will be eliminated. The most difficult case is where the stone shadow lies between these limits. If the patient has already passed stones from this kidney it is probable that the ureter is somewhat dilated and one should wait to see if he can pass this one also. On the other hand, if the stone is giving rise to severe pain which is seriously interfering with the patient's work, operation should not be delayed. The composition of the stone should also be taken into account. This can be estimated fairly accurately by examining the urine for crystals. A cystine or uric acid calculus is eliminated much more easily than an oxalate stone of the same size.

Any stone that has become moulded to the cavity in which it lies requires operation. It cannot be passed naturally. Thus a triangular stone in the renal pelvis or a collar-stud calculus in a calyx can only be removed by operation no matter what its size may be.

A slight degree of infection is not a contraindication to a conservative operation and extremely good results can be obtained by pyelolithotomy. On the other hand, a grossly infected kidney containing large masses of stone should be removed as soon as possible provided its fellow is healthy. The greatest difficulty arises in cases where a moderately infected kidney contains a dendritic calculus which has not seriously diminished its function. Much depends on the size and shape of the projections lying in the calyces. If they

are long and club shaped it would be impossible to remove the calculus without slitting up each calyx. This would do so much harm that a primary nephrectomy is preferable. If the projections are short and stumpy, they may be withdrawn from the mouths of the calyces without damage. In this case it may be possible to remove the calculus through a pelvic incision.

Multiple stones create other difficulties. If they are very numerous a nephrectomy is indicated as it is impossible to remove them all and a rapid recurrence is the rule. If a comparatively small number less than ten or so are present, their individual shadows appear on the X-ray film. The most common arrangement is to find a comparatively large stone blocking the renal pelvis, while the others are much smaller and lie in the calyces. The pelvic stone can be removed by pyelolithotomy and most of the others can be picked out of the calyces with a long slender forceps. If this is impossible a limited cortical incision can be made over the calyx in which they lie. It may be necessary to make two or three such incisions before the kidney is completely cleared of stones. It is in cases of this type that radiography during operation is so useful.



FIG. 424

Pyelolithotomy combined with a limited nephrolithotomy. The pelvic stone has been removed. A small incision is made directly on to the stone in the calyx, which is held in place by the surgeon's finger introduced through the pelvic incision.

**PIELOLITHOTOMY**—When the kidney has been exposed (see p. 145) it is brought well out on to the loin. The peripelvic fat is cleared off the posterior surface of the renal pelvis. The surgeon then grasps the kidney in his left hand. The tips of the index and middle fingers should compress the anterior lip of the renal sinus, while the thumb compresses the posterior lip. In this way the stone, which is felt within the renal pelvis is prevented from slipping back into one of the calyces. The incision in the pelvic wall commences about 2 or 3 mm from the posterior lip of the sinus rather above its middle, and is continued towards the uretero-pelvic junction. *It should stop short of this point, as if it is carried right down to it a stricture may afterwards form.* The surgeon cuts directly on to the stone, which is felt grating against the point of the knife. The stone is then removed by means of a forceps or a small scoop. The incision in the pelvic wall should be long enough to permit removal of the stone without lacerating or bruising its edges.

The next step consists in exploring the kidney. A finger is inserted into the renal pelvis and the mouth of each calyx is palpated. If counter pressure is exerted on the corresponding portion of the convex border of the kidney quite small stones in the calyces will be detected. They may be removed by means of a slender curved forceps introduced through the pelvic incision. If this fails, a small cortical incision is made over the calyx, while the surgeon blocks its mouth with his fingers (Fig. 424). The last step is to verify the calibre of the ureter. A No. 10 or 12 Charrière bougie should be passed down to the bladder.

The pelvic incision should always be sutured. If the renal pelvis is dilated and the incision comparatively long a continuous suture of fine catgut is best. If the incision is short two or three interrupted stitches suffice. A couple of stitches unite the fatty tissue over the pelvic wall and serve to bury the wound in it. The kidney is then replaced, a drainage tube is placed close to the pelvic incision and the main wound is closed in the usual manner.

**MODIFICATIONS OF PYELOLITHOTOMY**—Many modifications have been described. They are all designed to give more room so that larger calculi may be extracted. For this reason the incision has been extended so that it involves the renal parenchyma as well as the pelvis. Unfortunately this does away with the advantages of a pure pyelolithotomy and increases the risk of secondary hæmorrhage and other complications.

*Pyelotomie élargie*.—Marion introduced this operation in 1922. He commences by opening the renal pelvis through a curved incision in the lowest third of its posterior wall. It begins just above the uretero-pelvic junction and curves upwards and backwards to the junction of the middle and lowest thirds of the renal notch. Marion then places two clamps on the edges of the kidney sinus to control the retro-pelvic vessels and continues his incision between them through the kidney tissue in the line of the lower calyx. The whole incision is curved with the convexity directed upwards. It is partly renal and partly pelvic and is about twice as long as the usual pyelotomy incision. It is most suitable for pelvic calculi which have a prolongation extending into the lower calyx. Its great disadvantage is that the retro-pelvic vessels are divided. This causes necrosis of a considerable amount of kidney tissue (Fig. 425).



FIG. 4

Fig. 4. *Pyelotomie élargie*. The incision is shown by the curved line while the shaded area represents the position of the calculus (after Marion).

*Inferior nephropyelolithotomy*.—This operation was introduced by Papin (and Zondek 1928) apparently independently. The kidney is exposed and dislocated out of its bed. The lower pole is tilted upwards so as to put the lower border of the renal pelvis on the stretch. The incision commences a few millimetres above the ureteropelvic junction and is continued along the lower border of the renal pelvis until the inferior angle of the renal sinus is reached. The knife is then carried along the inner border of the kidney as far as the lower pole opening up the whole of the lower calyx. The operation gives ample room for removing really large calculi and permits a thorough exploration of the whole of the pelvocalyx system. Unfortunately it is occasionally followed by secondary hæmorrhage but this is the only complication I have observed (Fig. 426).

**NEPHROLITHOTOMY**.—This operation is indicated when the stone sends projections into one or several calyces. Usually the largest of them lies in the lowest calyx and it should be first opened. The incision through the kidney tissue is made parallel to and about 5 mm. behind the convex border (Fig. 427). To open the lowest calyx the middle of the incision lies at the junction of the

middle and lowest thirds of the border (Fig 428) The surgeon cuts directly on the stone which can be felt through the kidney tissue and the point of

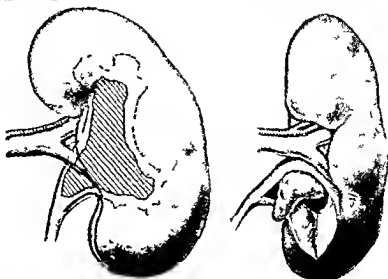


FIG 426

Inferior nephropyelotomy The course of the incision is shown on the left and the space obtained on the right In both figures the renal portion of the incision might have been prolonged with advantage (After Papin)

the knife should grate against it The stone is gently freed taking care that each projection is completely liberated from the calyx in which it lies This may necessitate enlarging the kidney incision If the surgeon attempts to



FIG 427

Nephrotomy The surgeon grasps the kidney firmly so as to immobilize the stone before making the incision

remove the calculus before it is completely freed he will certainly break it and may have great difficulty in extracting all the fragments The liberation of a large branched calculus is a difficult and tedious process but it is essential if the calculus is to be removed intact When the stone has been removed it is

examined for signs of fracture. If any are found the corresponding calyces must be investigated. If necessary fresh incisions should be made over them. When the stone has been completely removed the ureter is explored by passing a bougie down it.

A nephrolithotomy may be necessary for a calculus entirely contained in the renal pelvis. This is indicated only when a pyelolithotomy cannot be performed as when the kidney cannot be dislocated on to the loin or when the renal pelvis lies entirely within the kidney sinus. Under these circumstances the empty lowest calyx must be opened. The incision is the same as that already described but one does not attempt to open the calyx blindly. The calyx lies at a depth of from 1 to 2 cm. from the surface and when the incision has reached this depth two small retractors are inserted and a search is made for the pearly white mucosa lining it. Once it is found the opening in it is enlarged until a finger can be inserted through it into the renal pelvis and the stone palpated.

An incision in the renal parenchyma is sutured by interrupted stitches. I use a double thread of fine catgut which is not so liable to cut through the kidney substance as a single thread of thicker material. Each stitch should traverse the whole thickness of the kidney tissue but should not penetrate into a calyx. Many surgeons tie these stitches over a pad of fat or muscle. This is useful if the kidney is not infected but if it is the pads will necrose and increase the sepsis.

Hæmorrhage is always troublesome in any operation involving the renal parenchyma. An incision just posterior to the convex border of the kidney coincides as nearly as possible with the line of demarcation between the areas supplied by the anterior and posterior branches of the renal artery. It can never be called a bloodless line but as no large vessels are divided the amount of necrosis following it is reduced to a minimum.

The technique of NEPHRECTOMY for stone is the same as that of nephrectomy for other conditions (see p. 154). The only point I wish to make is that if the perinephric fat is increased in amount and is fibrotic it is usually advisable to remove it with the kidney. It is generally possible to find a plane of cleavage between it and Zuckerhandl's fascia through which the kidney enclosed in its fatty envelope can be enucleated. If no such plane of cleavage can be found one may be forced to do a subcapsular nephrectomy (see p. 110).

PARTIAL NEPHRECTOMY is occasionally indicated in cases of double kidney, one half of which contains a stone. As each portion has its own ureter and blood supply the operation presents no difficulty. The ureter and the blood vessels of the diseased portion are first tied off and divided. A flap of the capsule of the diseased portion is turned up and a transverse incision is made along the furrow which indicates the line of demarcation between the two portions. The capsular flap is sutured over the raw area.

If the lower pole of a normally formed kidney is extensively cavitated and contains little or no renal tissue it may be resected by means of a curved incision.

**Ureteric calculus—CYSTOSCOPIC MANIPULATIONS.**—The pain of a renal colic is instantly relieved if a catheter can be passed above the stone. A rather large and fairly stiff instrument may be used. It is probable that it displaces the stone upwards and so allows the urine to escape. If it fails a small flexible instrument should be tried, it may pass the stone. The catheter may be left in position for twenty-four hours and before withdrawal 1 or 2 c.c. of liquid paraffin should be injected through it (Fig. 429).

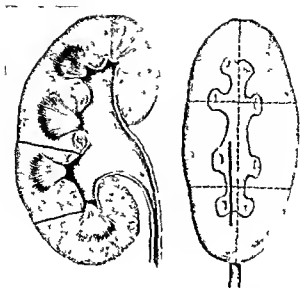


FIG 428  
Nephrolithotomy Position of incision to open up the  
lowest calyx



FIG 429  
Radiogram of a small calculus in the lower end of the  
left ureter. The stone was passed naturally after  
dilatation

Manipulations to favour the passage of the stone should not be attempted if the stone is larger than an orange pip. They generally fail unless the stone lies below the level of the spine of the ischium. The chief indication for these manipulations is furnished by cases in which a small stone lies close to the bladder but shows no signs of passing into it. They are contraindicated in cases of large stones, marked dilatation of the kidney and severe sepsis. If one attempts to entangle a stone between two or three catheters and then pulls it out one will probably do so much damage to the ureter that a stricture subsequently forms. Repeated attempts to extract a calculus are dangerous. Dilatation with metal instruments should also be avoided.

A ureteric mentotomy is performed by means of an endothermy electrode by which the vesical orifice is slit up for a distance of about a centimetre (Fig 430).

If the stone lies in the intramural portion one can usually see it drop into the bladder. If it lies entirely outside the bladder it usually comes away

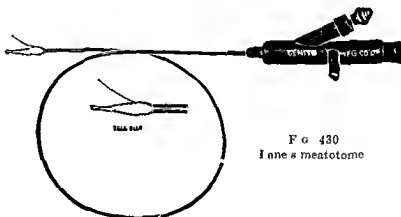


Fig 430  
Intra-ureteric mentotomy

within the next forty eight hours. Occasionally it may remain for some weeks in the ureter but when it does pass it comes away painlessly.

**URETEROLITHOTOMY**—This operation is indicated in cases where the stone is too large to be passed naturally or when there is progressive dilatation of the kidney above it (Fig 432). It should be done without delay in cases of bilateral stone or when the calculus lies in the ureter of a solitary kidney on account of the risk of calculous anuria. Infection is another indication for early operation.

The technique of exposing the ureter and removing the stone is given on p 201.

**NEPHRO URETERECTOMY** is indicated when a ureteric calculus has given rise to a pyonephrosis. The ureter is divided below the calculus, is freed upwards as far as possible and is packed into the iliac fossa. The patient is then turned over and the kidney and ureter are removed through the usual loin incision.

**Dissolution of renal calculi**—In 1939 Albright, Sulkowitch and Chute reported that an isotonic citrate solution of a pH of 4.0 had been used experimentally and clinically to dissolve calcium phosphate stones. In spite of the excellent solvent action of this fluid it was found to cause too much pain, oedema and hæmorrhage for extensive use. After further investigation it was discovered that the addition of magnesium ions considerably reduced the irritating action of the citrate. This fluid known as solution G was advocated by Suby—citric acid (monohydrate) 32.25 gm, magnesium oxide (anhydrous)



3.84 gm, sodium carbonate (anhydrous) 4.37 gm, water q s ad 1000 cc—for the dissolution of calcium phosphate carbonate and magnesium ammonium phosphate stones. In order to keep the maximum amount of fluid in contact with the calculus for as long as possible Suby described two types of tidal irrigation apparatuses which otherwise would have to be carried out by constant injection of the fluid by a syringe.

The routes by which the fluid may be brought into contact with a renal calculus are either (a) through a nephrostomy by the use of one or more tubes or by a ureteric catheter with a nephrostomy tube for an exit, or (b) one or more ureteric catheters passed into the pelvis of the kidney via the bladder and ureter.

This method has a definite place in the treatment of renal calculi when used through or in conjunction with a nephrostomy tube.

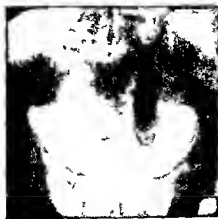


FIG 432

Radiogram of an enormous ureteric calculus. Antero-posterior view.

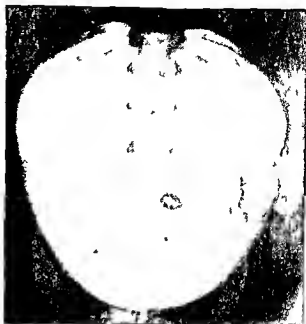


FIG 431

Radiogram of a small calculus projecting from the vesical orifice of the left ureter. The patient was cystoscoped shortly after the radiogram was taken and the calculus was liberated by enlarging the orifice. Note that the shadow lies close to the middle line and that its long axis is horizontal—it simulates the shadow of a vesical calculus.

But when the fluid is injected into a closed renal pelvis by means of one or more ureteric catheters the results have frequently been so unsatisfactory that many urologists are much averse to it.

#### BILATERAL LITHIASIS

**Indications for operation in bilateral lithiasis**—A certain amount of confusion of opinion has arisen as to the best line of treatment in these cases. In this paragraph I wish to discuss chiefly the question as to the side on which the first operation should be performed and also the interval that should be allowed to elapse between the operations. It is rarely advisable to operate on both sides at the same time as patients suffering from bilateral lithiasis are seldom fit enough to stand a double operation.

When the kidneys are not infected the stones are usually comparatively small the renal function is fairly well preserved and is approximately the same

on both sides. In such cases a pyelolithotomy can be done on both kidneys and the only point I wish to make is that the interval between the operations should be as short as possible (two or three weeks). If on the other hand one kidney has been severely damaged and the renal function on the two sides is unequal one should operate first on the damaged kidney and allow it a considerable time to recover (four to six weeks). It is almost certain that the kidney will recover the greater part of its lost function after operation provided sufficient time is allowed.

When stones are found in one kidney and the opposite ureter one should operate on the ureteric calculus first as it usually does more damage to the kidney than one lying in the renal pelvis.

If one kidney is infected while the other excretes sterile urine one should operate first on the infected organ. During convalescence an attempt should be made to clear up the infection by means of sulphonamide drugs. In most of these cases the infection is comparatively slight and good results may be expected from chemotherapy.

The greatest difficulty arises in cases where both kidneys are infected. If the function on both sides is approximately the same one should operate first on the side in which the smaller stone is found. The first operation is always the more dangerous and should therefore be as simple as possible. A pyelolithotomy is easily borne by patients who would not stand an extensive nephrolithotomy. In these cases the interval between the operations should be as short as possible.

When the function on the two sides is unequal one must endeavour to determine whether the severely damaged organ can recover its function after operation. If it is thought that it can recover the stone should be removed as soon as possible and a long interval allowed for recovery to take place. One can then deal with the better kidney. If one kidney is irreparably damaged it is usually pyonephrotic. When it gives rise to much pain and severe constitutional symptoms it should either be removed or drained. In these cases a temporary nephrostomy is often of great value. When the patient has recovered as far as possible the stones may be removed from the opposite organ. Occasionally it is advisable to operate first on the better kidney. If it is only slightly infected and contains a small stone the calculus should be removed. Sulphonamide treatment is then started and when the maximum effect has been obtained a nephrectomy can be carried out on the opposite side.

There is one practical point which should be borne in mind. When one kidney has been destroyed or removed its fellow becomes hypertrophied unless it is heavily infected. In a hypertrophied kidney the renal pelvis tends to become completely hidden in the deep renal sinus and a pyelolithotomy may be impossible. One may then be forced to do a nephrolithotomy on the type of case in which a pyelolithotomy is so much to be preferred.

### RECURRENCES

There is no doubt that recurrences are much more common than was formerly supposed. This applies especially to infected cases. A pyelolithotomy for uninfected stone was followed by a recurrence in 3.7 per cent while the same operation in the presence of infection was followed by a recurrence rate of 20 per cent. Here were 48 per cent of recurrences in cases where infected calculi were dealt with by nephrolithotomy or one of its modifications.

Recurrences are of two types. In the first the operation is incomplete and stone shadows may be seen on X ray films taken during convalescence. The second type is due to renewed stone formation. The X ray films are at first negative but sooner or later small shadows appear which gradually increase in size. In both cases the recurrent calculi are small and are often eliminated naturally.

Special precautions should be taken to minimize the risk of a recurrence. The first of these is the choice of operation. When the non calculous kidney is not infected conservative treatment of the diseased organ should not be pushed too far. If the stones are large multiple and the kidney infected nephrectomy gives the best results. The risk of a recurrence on the opposite side after this operation is approximately 1 per cent.

If nephrectomy is contraindicated it is extremely difficult to make certain that one has removed every stone or grain of sand. The surgeon should always have a plain X ray film and a pyelogram in the theatre and should not rest satisfied until he has accounted for every shadow on them. This is however no proof that all the stones have been removed. It is in such cases that radio-graphy during operation has proved of value. If no shadows are seen on the film the surgeon may be satisfied that he has done all that is possible. A positive finding tells that his task is not finished but it gives him very little help in locating the missing stone. All that one can gather from the skiagram is that the stone lies in the upper middle or lower third of the kidney.

No matter whether a recurrent calculus is due to an incomplete operation or to fresh stone formation it tends to lie in one of the calyces generally the lower one. Its subsequent growth is favoured by continued sepsis and inadequate drainage.

The treatment of the renal infection is part and parcel of the treatment of the lithiasis. In every case in which a conservative operation is performed for infected stone the surgeon should endeavour to eradicate the sepsis. The best time for this part of the treatment is during the convalescence after operation and a full course of chemotherapy should be given before the patient leaves hospital.

If a stone is found in one of the calyces one should facilitate its escape into the renal pelvis. This may be achieved by postural treatment. The patient should be instructed to sleep on the sound side. If it lies in the lower calyx the foot of the bed may be raised with advantage. The position of the stone must be verified from time to time by means of X ray examinations.

Occasionally the lower calyx is transformed into a large cyst like cavity with rigid walls by the growth of the original stone. It may then be of use to resect the lower pole of the kidney when dealing with the original calculus.

### CALCULOUS ANURIA

This is an obstructive anuria due to the presence of one or more calculi lodged in the upper urinary tract.

**Ætiology**—Calculous anuria is comparatively rare. There were 5 cases of it in the 518 cases of stone in the upper urinary tract seen at St. Peter's Hospital. Brongersma (1924) reported 5 cases among his 244 cases of kidney stone. Four of them were due to bilateral stone and the fifth to a stone in a solitary kidney. Rosving had 17 cases of anuria in 385 cases of renal or ureteric lithiasis and Caulk (1925) had 6 in 280 cases.

It is more common in the male than in the female. Most statistics give the ratio of males to females as approximately three to one.

The average age of the patient is from 40 to 60, but no age is immune. In a few instances calculous anuria has been observed in infants or in extreme old age.

The stone is usually small. It is rarely larger than an orange pip. Large calculi do not give rise to obstruction but they gradually destroy the kidney and render it incapable of excretion. In such cases the real cause of the anuria is a small stone on the opposite side. Occasionally the obstruction is due to collections of sand or gravel. In one of the cases at St. Peter's Hospital there was a collection of uric-acid sand in each ureter. The stones are usually composed of oxalates or phosphates or a mixture of these two. Some authors are of the opinion that uric acid calculi are particularly prone to give rise to obstruction.

**TYPES OF OBSTRUCTION**—At least three types of obstruction are to be considered. They are —

- 1 Obstruction of both kidneys or ureters
- 2 Obstruction of the only functioning kidney
- 3 Unilateral obstruction

*Obstruction of both kidneys or ureters*—Ehot (1910) collected 64 cases of this type. In 47 of them both ureters were blocked by stones, in 8 there was a stone in one ureter and another in the opposite renal pelvis, while in 9, stones were present in both renal pelves.

Bilateral ureteric calculus is the rarest form of bilateral lithiasis, yet it is most often followed by anuria. This shows the necessity of avoiding delay in treating the condition. It is also interesting to note that in two-thirds of the cases of anuria the calculi lay in the upper third of the ureter.

When the stone lies in the kidney it blocks the ureteropelvic junction. The calculus is usually small and single so it can easily be removed by pyelolithotomy.

There is only one practical point in dealing with cases of bilateral obstruction. If the stone on one side has been removed during an emergency operation one should deal with the opposite kidney or ureter with as little delay as possible. Prolonged obstruction is most injurious and may destroy the kidney. One should operate on the second kidney as soon as the patient has recovered from the immediate effects of the anuria and the blood urea has returned to normal. This usually takes from three to five days so that the second operation should take place within a week of the first.

*Obstruction of the only functioning kidney*—There are three types of cases in this group. In the first there is congenital absence of one kidney, in the second one kidney has been removed surgically, while in the third one kidney has been completely destroyed by disease.

Congenital absence of one kidney is not as rare as was formerly supposed. Morris considered that this anomaly occurred about once in 2,400 cases. Ehot collected 18 cases in which the ureter of a solitary kidney was occluded by a stone and many more have been reported since. In 14 of these cases the absence of one kidney was confirmed by a post mortem examination, in the remainder it was made by finding only one ureter on cystoscopy.

Obstruction of the remaining kidney after nephrectomy is not uncommon. Ehot collected 32 cases of this type in 23 of which the kidney was removed for stone. In the other cases it was removed for tuberculosis or new growth. When the anuria occurred late it is almost certain that it was due to fresh stone formation. At the same time recurrence on the opposite side after nephrectomy is not common (1 per cent. St. Peter's Hospital, 2 per cent. Brongersma).

In Elliot's third type of case one kidney was destroyed by disease while its fellow was occluded by a stone. He collected 19 cases of this type. The most common lesions found in the functionless organ were pyonephrosis, tuberculosis (either complete caseation or an occluded kidney) and total hydronephrosis.

*Unilateral obstruction*—Elliot collected 19 cases of this type. In most of them the unobstructed kidney appeared to be infected or else the seat of a chronic nephritis. In several of them excretion was known to have been re-established after the stone on the opposite side was removed. In two instances the unobstructed kidney was exposed by operation and found to be congested. A stone was found in the opposite kidney at the post mortem examination. In two other cases a nephrostomy had previously been done. Urine ceased to flow from the tube when the opposite side became obstructed but commenced again after the calculus was removed.

It is frequently stated that the arrest of excretion on the unobstructed side is due to reflex action and the term reflex anuria is commonly employed by continental surgeons. On the other hand many authorities deny the existence of such a reflex but unfortunately they do not give a satisfactory alternative explanation. If the secretion of urine can be inhibited by reflex action it must be under control of a nervous mechanism. No secretomotor nerves have been found in the kidney. The nerves of the renal pedicle are vasomotor. The kidney can function perfectly after it has been transplanted into some other part of the body and its vessels connected up with a local artery and vein. By this means its nervous connections have been completely severed and the experiment proves that the secretion of urine is not controlled by any nervous influence. This in itself is enough to disprove the theory of reflex inhibition.

Complete anuria from unilateral obstruction can best be explained by a fall in the systemic blood pressure (1934). The secretion of urine is a double process of filtration and selective absorption. The glomeruli are simply filters which hold back the plasma colloids but allow water and crystalloids to pass through into the convoluted tubules. The function of the tubules is to absorb water and certain substances such as chlorides and sugar which are of use in the economy while waste products are eliminated. It is obvious that filtration will not take place unless there is a difference of pressure on the sides of the filter. Thus if the blood pressure falls the filtration pressure in the glomeruli is reduced or is abolished. In the first case there is an oliguria, in the second, anuria.

When anuria follows unilateral obstruction pain always appears to be a prominent symptom. It reduces the blood pressure and so may give rise to anuria. The anuria persists as long as the pain continues. If a catheter can be passed above the stone the pain is relieved and excretion is re-established on both sides. If the path of the painful impulses is blocked by an injection of novocaine round the semilunar ganglion the excretion recommences but may cease when the effect of the anæsthetic wears off.

*Symptoms and signs*—Calculous anuria may commence with an acute renal colic or its onset may be painless and insidious. In the latter case the obstruction is generally bilateral.

Usually the patient gives a long history of urinary lithiasis and may have undergone several operations for stone but in about 20 per cent of cases the anuria is the first symptom. Prodromal symptoms are on the whole rare. The patient may complain of a renal ache or may notice a progressive oliguria lasting for a couple of days before the onset.

In the classical description of the condition the onset is said to be painless. The patient notices that he has not passed urine for several hours and when he tries to do so he finds that his bladder is apparently empty. He may not seek advice for two or three days. A catheter is usually passed and the bladder is found to be empty. In other cases the anuria commences during an acute renal colic. The position of the pain then indicates the side obstructed and the diagnosis is made early. This is naturally to the patient's advantage.

There are two well-marked periods in the clinical course of calculous anuria. The first is the period of tolerance and the second the period of intoxication.

During the PERIOD OF TOLERANCE the patient feels perfectly well and may carry on his usual work. The only indication that his condition is really serious is a steady rise in the amount of the blood urea. It may reach 100 mg per 100 c.c. by the third day and is usually over 200 before toxic symptoms appear. The anuria is rarely complete, in most cases a few cubic centimetres of blood stained urine are passed each day but the quantity is quite insufficient to eliminate the nitrogenous waste. In other cases periods of anuria alternate with others of polyuria. This only lengthens the duration of the period of tolerance and does not prevent the ultimate onset of toxic symptoms. The average duration of the tolerant stage is from four to six days. It may only last for twenty four hours or may extend to twelve or fourteen days.

The onset of the PERIOD OF INTOXICATION is gradual. The first symptoms are thirst, a dry tongue, distaste for food, constipation with abdominal distension and drowsiness. At first there is a craving for water but later this is refused. Vomiting is uncommon but when it does occur it may be very profuse. Hiccough may be a distressing symptom and prevent the patient from sleeping. It is most common when the kidneys are infected.

Nervous symptoms appear soon after those connected with the digestive tract. They are headache, which is rarely severe, drowsiness, which soon deepens into a state of semi coma, and mental confusion. The patient lies in a listless apathetic state. He does not recognize anyone but may answer correctly if spoken to. There is often a long pause between question and answer, as if the reaction time was enormously prolonged. All forms of fluid or food are refused. The patient lies with his eyes closed and usually without movement, save for slight twitching of his muscles. This has been described as a state of *'sleepiness without sleep'*. The breathing is deep and slow, and as the mouth is kept open it may be stertorous. Towards the end Cheyne-Stokes breathing is common. The temperature is subnormal. The blood pressure gradually falls and death supervenes almost insensibly.

During the whole period of anuria the blood urea steadily increases in amount. The highest figure I have seen recorded was 610 mg per 100 c.c. but figures above 500 were not uncommon. The mortality in untreated cases is about 70 per cent.

Dis-impaction of the stone, either spontaneous or by means of a ureteric catheter, is followed by a very profuse polyuria. This washes the nitrogenous waste out of the blood stream so that the blood urea rapidly falls and there is a corresponding improvement in the patient's symptoms. But unless the stone has been eliminated there is a risk that the anuria may recur.

**Examination and diagnosis**—The diagnosis of anuria is easy. The patient has not passed urine for a considerable time and a catheter shows that his bladder is empty.

The first point to be ascertained is which side is painful or on which side was pain last felt. Pain is always an indication that the kidney was capable

of functioning. This is confirmed if the kidney is tender or if there is rigidity of the flank muscles over it. Rigidity and tenderness are valuable signs as they persist for several days after the pain ceases. The obstructed kidney is rarely much enlarged and may not be palpable. If the patient has scars in one or both loins one must endeavour to ascertain if a nephrectomy has been performed. Usually the patient can give definite information on this point unless he is comatose. If one kidney is greatly enlarged it is probably pyonephrotic and the surgeon should advise operating on the opposite side. An X-ray examination may give inconclusive information. The patient's abdomen is often distended with gas and there is no time to prepare him for the examination. The obstructing calculus is usually small and may not be visualized under these conditions. If a giant calculus is found on one side it is usually an indication to explore the opposite kidney.

Anuria may be caused by compression of the ureters by a malignant growth in which case one finds a large and hopelessly inoperable pelvic tumour. Anuria due to poisoning by corrosive sublimate is preceded by intense gastro intestinal irritation. It may follow a short period in which the urine is scanty, highly albuminous and contains epithelial cells and casts. The diagnosis is usually easy unless the patient wilfully misleads the surgeon.

**Treatment**—The first consideration is to restore the urinary excretion. When this has been accomplished one can wait until the patient's condition improves before removing the calculus. The first step is to drain the kidney either by a temporary nephrostomy or by a ureteric catheter and this drainage must be maintained until the obstruction has been removed.

**CATHETERIZATION OF THE URETERS** is the simplest method of draining the kidneys but it is uncertain and should not be attempted unless the surgeon is prepared to operate immediately if it fails.

When the cystoscope has been passed one usually finds that both ureteric orifices are normal in appearance but are motionless. No additional information as to the side last obstructed is obtained. The surgeon then attempts to pass a catheter up the side on which he considers obstruction to have last taken place. The catheter usually passes easily until the lumbar portion of the ureter has been reached then further progress is arrested. The surgeon should use every endeavour to overcome this resistance. Catheters of different size and flexibility should be used. A large stiff instrument may displace the stone upwards into the renal pelvis but must be used with caution. A thin flexible catheter may slip past the stone. In either case urine soon drains from it. As soon as this occurs the surgeon should attempt to catheterize the opposite side. If he succeeds the cystoscope is removed taking great care not to displace the catheters. When he is certain that there is a brisk elimination of urine from one or both sides he may safely leave the patient. In many instances the diuresis is very profuse and as much as 200 to 300 oz (roughly 6 to 8 litres) may be collected in twenty four hours. This is accompanied by a rapid fall in the amount of the blood urea which may reach normal figures in a few days.

Once the blood urea becomes normal in amount the catheters are withdrawn. This is the critical period in the treatment. Withdrawal of the instrument may be followed by the passage of the calculus. This is the most satisfactory result and if there is still a stone in the opposite kidney or ureter it can be dealt with when convenient. If the stone is not passed but the patient continues to secrete urine a set operation for the removal of the stones should be performed without delay. It is then safe as the patient is relieved of the harmful effects of the obstruction. If however the obstruction

returns, an immediate operation should be performed. It is important not to let the blood urea rise again, as this undoes the good results obtained by catheterization.

An operation carried out in the course of anuria should always be considered to be an emergency measure to drain the kidney. If a stone is found in the renal pelvis or in the upper portion of the ureter, it may be removed

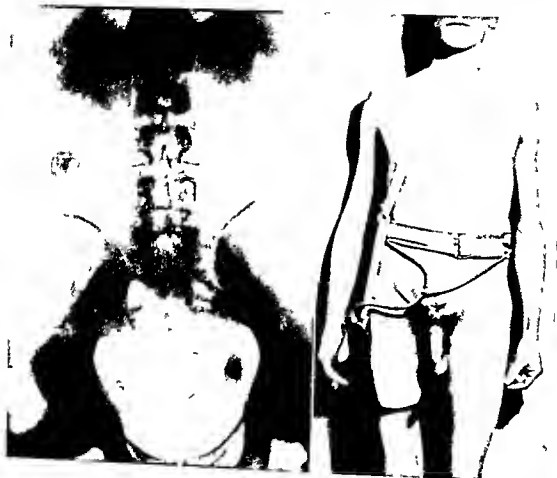


FIG 433

Stones in both kidneys and both ureters, removal of all stones and bilateral nephrostomy. (Mr. Winbury White's case)

provided this does not unduly prolong the operation. The operations usually performed under these conditions are either a nephrostomy or a pyelostomy (Fig. 433).

When the kidney is exposed, it is usually found to be slightly enlarged and very congested. The renal pelvis is usually somewhat dilated but it is rarely tensely filled and may be empty. Its posterior wall is incised and any stones lying in it are removed. The upper two or three inches of the ureter may also be palpated, and if a stone is felt it may be removed. This part of the operation should only be done when the patient's condition is fair. A self-retaining tube is then passed through the incision in the renal pelvis and the wound is closed. A pyelostomy done in this way is, in my opinion, safer than a nephrostomy. The latter operation is usually followed by fairly severe hemorrhage from the congested renal parenchyma, which the patient is not



in a fit state to stand. An intravenous drip of 5 per cent glucose solution is given after the operation.

If the kidney is found to be obviously incapable of excretion the surgeon must turn the patient over and drain the opposite organ. He has no alternative. Drainage of a severely damaged and usually pyonephrotic organ will not help the patient. This double operation unfortunately has to be performed on patients least able to stand it.

J. SWIFT JOLA

(Revised by J. E. SEMPLE)

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## CHAPTER LXXXI

### CALCULOUS DISEASE OF THE BLADDER

#### ÆTIOLOGY

**I**T is difficult to be certain in what proportion bladder stones arise locally or are passed down from above but there is no evidence to indicate that the majority of vesical calculi do not originate in the bladder

**Sex and age**—The male sex has always been more prone than the female to vesical calculus, but in recent years there has been a tendency for this difference to be less marked, for Freyer, in 1908, reported 98 per cent in the male and my own cases to day show 84 per cent in this sex. This change is due principally to the widespread practice of dealing surgically with bladder-neck obstructions in men. A less important contributory cause, however, is the fact that there has been a definite tendency for stone in the bladder to increase in women (Lett 1936). The latter fact is probably associated with the increase in pelvic operations in the female sex.

With regard to age during the first two decades of life the incidence is not only uncommon but it remains stationary, after that it steadily increases up to the seventh decade during which period cases of prostatic obstruction so frequently occur.

**Deficiency disease**—When we consider urinary calculus as it occurs amongst us at the present time we are struck with the different form which this disease takes compared with the incidence of it up to the end of the last century. For until that time this complaint was mostly found in the form of vesical calculus in children of the working classes. When we realize that this type of case is practically non-existent in Great Britain to day, and that the maximum incidence of urinary lithiasis is in the upper urinary tract towards the end of the fourth decade, we certainly find ourselves with some interesting food for thought. The disappearance of vesical calculus in children has been gradual and has gone hand in hand with the improving standard of living in the lower strata of the population. The fundamental cause of vesical calculus when it occurs commonly in children has been shown to be dietetic, the principal faults being a deficiency of vitamin A of animal origin and of calcium in an absorbable form. These essential food constituents are supplied in considerable quantities in butter, milk, and other animal fats, and these articles of diet were largely lacking to a poverty-stricken population. Experimental evidence indicates that these food faults produce vesical rather than renal calculus. On the other hand, there is a lack of evidence to support the view that such food faults play any part in producing the renal calculus cases which occur commonly amongst us to-day. The first important proof of the influence of vitamin A deficiency on the incidence of lithiasis was put forward by Osborne and Mendel in 1917. Further support for their findings was forthcoming from Grossmann (1933) and McCarrison (1931). The last worker demonstrated that stone was only one of the diseases produced by a faulty diet. He also showed that stone was often the result of more than one food-fault. He fed rats on the diets of those peoples of India amongst whom stone

was common and by modifying the feeding of his animals he was able to demonstrate a number of factors that combined to play a part. His conclusions can be summarized in his own words as follows. There appear to be two categories of dietetic factors in stone formation: (a) positive factors including excess of lime in the diet and some unknown agent present in whole cereal grains; and (b) negative factors including deficiency of vitamin A derived from animal sources and deficiency of phosphates relative to the amount of lime in the diet.

It would be misleading to suggest that because whole wheat flour and oatmeal when they compose the major part of an unbalanced diet are stone producing they should be displaced from the dietaries of mankind. They may always be regarded as desirable constituents of a mixed diet when present in moderate proportions. As for excess of lime and deficiency of phosphates, an ordinary mixed diet as exemplified in modern living conditions provides the proper balance of these constituents. The imbalance of any one of these substances becomes a source of danger only in the presence of other stone producing factors. The decline in the incidence of bladder stone in Western Europe and Great Britain has gone *pari passu* with the more common use of butter and milk in the diet and the substitution of white flour for whole wheat flour which at one time formed the principal article of food for the masses. In Great Britain in former days whole stone was common in certain parts yet there were adjacent localities which were particularly free from the complaint. It was in fact in the counties where the best pasture land was found that stone was not prevalent for in these districts milk and butter were commonly available. There can be no doubt also that where other stone forming factors were present the excess of lime which was often present in the water in some areas played its part. In South Staffordshire for example urinary lithiasis diminished when a softer water than was formerly used was obtained by sinking wells to a deeper level.

**Retention of urine and infection**—These two factors must be looked upon as of prime importance in the aetiology of vesical calculus. Generally the retention precedes the infection and it may be said that the tendency is in cases of retention for infection to be superadded in due course but in some cases it is not certain which has occurred first. A number of conditions should be specially considered in this category.

**ENLARGED PROSTATE AND BLADDER NECK OBSTRUCTION**—Prostatic obstruction may be taken as the commonest single cause of vesical calculus where living conditions are of a good standard. In most cases in due course infection as well as obstruction contributes to the growth in size of the stone. The fibrous type which is usually the result of long continued inflammation is a very important cause because with it there is often some active inflammation as well thus the two most important predisposing causes of vesical calculus exist together.

**URETHRAL STRICTURE**—This must be considered to be of great importance in the aetiology of vesical calculus for two reasons especially infection is a condition which accompanies most cases of stricture from the beginning advanced cases of stricture are generally accompanied by a generalized constriction of the internal urinary meatus.

**IMPAIRED NERVE CONTROL OF BLADDER**—Where there is residual urine which remains indefinitely infection inevitably intervenes and stone formation is likely to occur.

**VESICAL DIVERTICULUM**—This occurs most commonly at the base of the bladder in adult males. There is in most cases a bladder neck obstruction

as well which gives rise to residual urine however the association between diverticulum and calculus is not so straightforward as one would expect. The most interesting point about this is that for a stone to be found only in the diverticulum is the least common state of affairs. The findings in an order of ascending frequency with regard to position of calculi may be stated as follows exclusively in diverticulum in both bladder and diverticulum in bladder only (Krayhan and Crampton 1932).

**CYSTOCELE (VESICO VAGINAL DISPLACEMENT)**—In the days when this condition in women was allowed to proceed to an advanced state without surgical aid vesical calculus sometimes formed in the resulting sac from which the drainage of urine was imperfect (Varner 1885). The circumstances which would give rise to stone formation are seldom seen nowadays.

**Foreign bodies**—see p 334

**Bilharzia**—see p 817

**Following intravesical operations**—This most commonly occurs after prostatectomy and is most likely due to calculous deposit on a piece of slough. Lett (1936) reported an incidence of 7.6 per cent. in 102 cases.

**Following fulguration of vesical papilloma**—This is a complication which has been reported by others (Dubner 1931) and I have had at least two such cases. It is most likely to occur where there is a fair amount of residual urine. This state of affairs allows slough to collect in the base of the bladder instead of passing per urethram.

**On vesical tumours**—The ulcerated surface of one of these may be the seat of a calculous deposit. Cystoscopically the condition may appear to be one of uncomplicated vesical calculus.

**Recurrence of vesical calculus**—The outstandingly important cause is a persisting bladder neck obstruction giving rise to residual urine combined with vesical sepsis. Other cases may be explained in a number of simple ways: a stone enters the bladder from above, a fragment is left behind on removing a stone, a series of unabsorbable threads migrate from an extra-vesical source through the bladder wall following a pelvic operation, a stone forms in a diverticulum. There are cases however, where the etiology is puzzling as in the following case. The patient suffered from simple enlargement of the prostate. I removed the gland in two stages. A stone was found at the first stage operation, another stone at the second stage operation some months later and about a year after the prostatectomy I crushed a third stone.

## PATHOLOGICAL ANATOMY

**Characters of vesical calculi—VOLUME**—A bladder stone may vary in size from that of a raspberry pip to that of a large orange or even larger. When multiple the more numerous the stones the smaller they are, generally one stone is much larger than all the others. When very numerous they vary in size from the smallest size shot to a pea. When thirty or forty stones are present they may be the size of walnuts (Desnos and Minet 1921). A stone the size of a hazel nut would be correctly described as small and one the size of a hen's egg as large. The majority of single stones for which advice is sought are of medium size.

The largest stone which I have been able to trace was recorded by Randall (1921). The specimen weighed 64 oz. in the moist state.

**NUMBER**—In about two thirds of the cases there is a single stone. When multiple there are generally not more than five. In exceptional cases the number may run into hundreds. Schurgius (Desnos and Minet 1921) on one occasion removed more than 2,000.

**CONFIGURATION**—A single bladder stone generally maintains an ovoid shape usually with a tendency to be flattened especially when formed in a well marked retroprostatic pouch. If the stone remains indefinitely in such a locality it gradually assumes the shape of the recess in which it is confined. A spherical form for a bladder stone is not common. Fig 44 is an exceptional example. A triangular shape is sometimes imparted as a result of the moulding effect of the vesical trigone. Indentations, facets and projections may be noted according to the condition of the bladder wall lying in contact with it or to the proximity of an intravesical projection of the prostate. The more extreme results of these influences are strikingly seen in stones which occupy both the bladder and a diverticulum or the bladder and the posterior urethra. Such stones are characterized by two expanded extremities connected by a narrow intermediate portion.

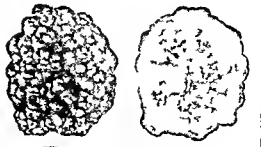


FIG 44

A calcareous ovalate stone of the typical mulberry variety. The convex face is also shown.

If the stone acquires unusually large dimensions it assumes not only the shape of the bladder which contracts upon it but it shows too impressions made by certain parts of the bony pelvis. There are certain large single vesical calculi recorded in the literature of such dimensions as to form a cast of the interior of the true pelvis.

Some of the rounded stones of the oxalate type have the surface covered with regular prominences in the form of spikes or less pronounced projections (Fig 434). Other stones have a perfectly smooth or a slightly roughened surface.



FIG 43

Three vesical calculi which were impacted in the post-prostatic pouch. (From *Stone and Calculous Disease of the Urinary Organs* by J. Swift Jones)

Parer forms have a somewhat curled and shell-like configuration which is due to the fact that the outer layers do not completely surround the nucleus. Multiple stones may become fixed at the base of the bladder and be faceted and have polished surfaces. When there are very large numbers present they remain small and keep their rounded shape because they are continually on the move.

For colour, weight, consistence, structure and composition see Characters of Urinary Calculi (p. 885).

**Situation**—As a rule calculi are free to move about the vesical cavity and change their position in response to body movement. In some cases, however, the stones become fixed to one locality in the bladder. Fixation of the stone may occur from a variety of causes. A number of stones may become faceted

and tightly wedged into the base of the bladder (Fig 435), as a result of the contracture of the upper part of the bladder upon a large calculus, the latter may become fixed and suspended from above, inflammatory vegetations may securely anchor a stone to the bladder wall, this generally occurs at the base a vesical calculus may occupy the bladder as well as a diverticulum, the posterior urethra or the vesical portion of the ureter, a stone has been found to project from the bladder into a fistulous track leading to the vagina or elsewhere foreign bodies of different kinds play a part in immobilizing calculi in certain situations I have seen a calculus suspended from the apex of the bladder by a piece of unabsorbable thread (Fig 170) The latter had entered the bladder wall from the uterus following a Casarian section An elongated object such as a nail in giving rise to a stone, will secure it in whatever position the foreign body takes up

**Fragmentation of vesical calculi**—In certain rare instances stones break spontaneously into pieces in the bladder The earliest evidence of commencing fragmentation is apparent in those stones which show on section fissures radiating either from the nucleus or from one of its overlying layers The breaking up, when it occurs, may give rise to numerous fragments, some of which may pass spontaneously or become impacted in the urethra Two cases have been described by Kasarnowsky (1908) in which the stones had disrupted into 127 and 236 pieces respectively

**The state of the bladder**—The vesical mucosa may be absolutely healthy in the early stages but a bladder cannot harbour a stone for long without undergoing local changes It is often impossible to be sure whether the cystitis which may be present has arisen as a complication or has preceded the formation of the calculus That portion of the mucous membrane which comes into contact with the stone—particularly the bed on which it lies—becomes congested and hyperæmic There is submucous ecchymosis and as the inflammation progresses there is bleeding from the mucous surface When the infection is well established the inflammatory process gradually spreads so as to involve the rest of the bladder

In advanced cases the inflammation will show itself as a well-marked vegetative or hypertrophic condition of the mucous membrane which bleeds constantly A false membrane may form on the bladder mucosa and become detached and adhere to the stone, which may be completely enveloped and thus rendered difficult to identify with the cystoscope

In rare cases a stone may be actually anchored through its rough projections to the vesical mucosa This probably only occurs when the stone owes its origin to phosphatic deposits on vegetations or ulcerated patches of the mucosa

The inflammatory changes in the wall of the bladder vary according to the length of standing of the disease, the degree of infection, the proximity of the various parts of the mucosa to the stone and the roughness of the latter Superficial ulceration is first noted on that part of the mucous membrane which forms the bed of the calculus This change may gradually extend to a considerable extent, so as to give rise to pericystitis and even to perforation into the vagina or rectum

Frequent contractions of the bladder caused by the presence of the calculus cause hypertrophy of the muscular coat, this is apparent from the fasciculations on the mucous aspect and the increased thickness of the bladder wall In due course, if the condition is old-standing, to these changes are added those of inflammation

Other striking changes which occur in some advanced cases are the

formation of a marked retrotrigonal pouch in which the stone rests the contraction of the upper part of the bladder upon the stone which it secures. This transforms the bladder cavity into an hour glass shape.

**Changes in the ureters and kidneys.**—In old standing cases as a result of the back pressure from the exaggerated contractions of the bladder the ureters become dilated tortuous and thickened. In extreme cases where the cavity of the bladder is completely occupied by a large stone the ureters may be so dilated as to act as reservoirs and so take the place of the bladder.

As the condition in the bladder deteriorates progressive chronic pyelo-nephritis with acute exacerbations occurs from ascending infection and the pelvis and calyces dilate from back pressure. Varying degrees of perinephritis are constant as soon as renal infection has become established.

### SYMPTOMS

There are three distinct types of these purely mechanical from the movement of the calculus—the so called classical symptoms resembling cystitis in general but suggesting stone in some respects no symptoms at all or these are slight or transitory.

**Symptoms due to movement of the stone.**—The cardinal signs in this respect are pollakiuria pain and hæmaturia. It is equally characteristic of them that they are relieved by rest.

**POLLAKIURIA** (frequency) is one of the early symptoms is more noticeable on movement than when resting and is particularly conspicuous when changing from the sitting or recumbent to the erect posture.

**PAIN** occurs as a result of movement and of micturition. In the early stages there is merely a consciousness of discomfort with body movements particularly with going downstairs or in a vehicle when it stops and starts. As the condition progresses the patient learns to descend stairs or from vehicles with a certain amount of caution and may prefer to stand rather than be seated in trains or buses which are frequently stopping and starting. The pain with micturition occurs as the act finishes and is due to contact of the stone with the bladder as the organ empties. As time passes the pain becomes more prolonged and intense in relation to micturition and if pollakiuria is marked pain may be almost constant. Bladder pain due to stone is seated in several situations according to the case deeply in the hypogastric or the pubic region or in the perineum commonly there is a burning or pricking sensation in the glans penis the pain may also be referred to the anus coccyx buttocks testicles or the thighs. When the pain becomes more constant there is often a sense of irritation in the penis which may produce a state of semi erection and in children this may lead to masturbation.

**HÆMATURIA**—This symptom may depend entirely upon movement as is seen by its appearance in relation to the patient's activities in this respect the amount of blood which appears tends to vary in the same way the blood being more towards the end of an active day and often absent entirely on getting up in the morning.

**INTERRUPTION OF STREAM RETENTION INCONTINENCE.**—Sudden stoppage of the stream during micturition occurs from other conditions as well but is likely to be due to stone when other symptoms of this disease are also present. Retention of urine is likely to occur when a small stone passes on into the posterior urethra. The state is generally only temporary if the stone moves forward in the urethra the urine escapes round it or the calculus is pushed backwards into the bladder when a catheter is passed. Incontinence

of urine may supervene if the stone is impacted at the neck of the bladder in which case the escape of urine is more or less continuous. Nocturnal enuresis is discussed below.

**Calculus associated with cystitis**—If a stone remains long enough in the bladder and any symptoms originally existed which were typical of stone these will in due course be obscured by those of cystitis for whereas the former depend mostly on movement the latter are present during rest as well. They also exist with greater intensity tend not to be aggravated to the same extent by movement and are invariably associated with pyuria. As the cystitis increases it is not only a question of pyuria but the urine contains mucus debris and phosphatic sand and becomes ammoniacal.

**Enuresis as a sign of calculus**—It is particularly in communities where living conditions are bad that vesical calculus will be found to be the cause of enuresis amongst children from time to time. In other circumstances this cause is rare. The incontinence is apt to take the form of a continual flow. Pain soon becomes prominent and other features suggesting stone gradually supervene.

### COURSE AND COMPLICATIONS

As a stone increases in size and in consequence becomes less mobile the tendency often is for the patient to be inconvenienced less by it than when it was small. In certain cases exceptionally large stones are discovered with which the mild symptoms form a striking contrast. In all cases however which are left long enough there comes a time when the symptoms of vesical infection dominate the picture. Exceptionally larger calculi may ulcerate their way through the bladder wall into the rectum or vagina as a consequence of which a urinary fistula results. Fragmentation of a calculus offers an opportunity for evacuation of some if not of all of the fragments per urethram.

Spontaneous evacuation of a small stone per urethram is the termination in some cases. A stone in escaping from the bladder may be arrested in the urethra and cause retention of urine in the first instance and by lodging in definitely in the urethra is likely to give rise to further local complications.

In long standing cases of vesical calculus changes in the kidneys and ureters from back pressure and infection are inevitable in some degree (see Pathological Anatomy).

### DIAGNOSIS

When the classical symptoms of stone are present especially where there has been a history of renal colic the diagnosis is straightforward. On the other hand sometimes the symptoms of stone are closely simulated by certain subjects suffering from cystitis a nervous disposition on the part of the patient seems to accentuate the similarity especially if it has been suggested to the patient that there is probably a stone in the bladder.

When the symptoms are those of cystitis the unremitting nature of the symptoms and their lack of response to treatment for cystitis should arouse suspicion.

The persistence of blood at the end of micturition should rightly turn one's thoughts to the likelihood of stone. Cases of cystitis with terminal hæmaturia are often wrongly thought to have vesical calculus but the transitory nature of this symptom is characteristic of inflammation.

The passage of an instrument will sometimes give a false impression that a stone is present. Fibrous tissue at the neck of the bladder or an incrustation on the bladder wall can each produce a friction suggesting the presence of



stone The familiar tap tap on the end of the catheter by the final contractions of the bladder as it empties may make the inexperienced observer think that the sensation thus imparted to the hand is due to a stone

Rectal or vaginal examination the passage of a metal sound radiography and finally cystoscopy all have their place as valuable diagnostic procedures The most important of these is cystoscopy

**Cystoscopy**—Often a stone which was never suspected is discovered by a routine examination of the bladder Of all the procedures this one can give the most valuable information Not only is the existence of a stone confirmed but so much data can be obtained about it which is important in making a decision about treatment

**CHARACTERS**—The size number and other features of stones present and their relationship to the bladder wall may be determined An opinion may even be formed as to the hardness of the stone for instance the surface

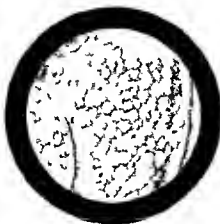


FIG 436

Cystoscopic view of portions of two large uric acid vesical calculi (From Stone and Calculous Disease of the Urinary Organs by J. S. Joly)



FIG 437

Cystoscopic view of a calculus which had recently entered the bladder from a ureter (From Stone and Calculous Disease of the Urinary Organs by J. S. Joly)

may show the characteristics of an oxalate stone This is important when litholapaxy is contemplated (Figs 436 to 440) The width of a stone can be measured in one direction by focusing the posterior edge of the calculus in the middle of the field and then withdrawing the instrument until the opposite edge comes into the same situation An assistant notes and measures the excursion of the instrument during this manoeuvre

**IDENTIFICATION**—In the majority of cases the appearance through the cystoscope of a small or moderate sized calculus is unmistakable The size contour colour and characteristics of the surface stand out perfectly clearly the whole of the presenting surface being visualized at the same time With a large stone however it will be necessary to view it from the neck of the bladder in order to get the maximum amount of the surface into the cystoscopic field It will be necessary also to manipulate the cystoscope round the stone in different directions in order to study the stone carefully

A small calculus in a sacculæ may be quite easily identified but it may be necessary to probe a stone firmly through an operating cystoscope to establish the fact that it is partly enclosed in a diverticulum

A calculus which projects into the bladder from a ureteric orifice is usually easy to identify as such by the appearance of the margin of the orifice which is generally the seat of considerable œdema



FIG 438

Cystoscopic view of an old blood clot coated with phosphates (From *Stone and Calculous Disease of the Urinary Organs* by J. Swift Jol.)



FIG 439

Cystoscopic view of a crystalline phosphatic vesical calculus (From *Stone and Calculous Disease of the Urinary Organs* by J. Swift Jol.)



FIG 440

Cystoscopic view of three phosphatic calculi in an infected and sacculated bladder (From *Stone and Calculous Disease of the Urinary Organs* by J. Swift Jol.)

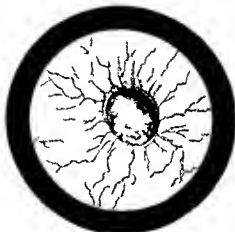


FIG 441

Cystoscopic view of a calculus lying in a small diverticulum (From *Stone and Calculous Disease of the Urinary Organs* by J. Swift Jol.)

The interpretation of appearances presents difficulties when a stone is covered with clot or debris, this may cause it to be mistaken for a tumour. A careful search, however, will generally disclose a part of the surface which is characteristic of calculus, or it may be necessary to probe the object under direct vision to determine its consistence. Sometimes it is wise to postpone a decision until a clearer view can be obtained as a result of a course of vesical lavage.

An incrustated tumour on the other hand can simulate a stone very closely if its presenting surface is completely covered with deposit but careful inspection will generally reveal the true state of affairs

The same precautions are necessary in the presence of plaques of incrustated cystitis but these are less projecting more irregular in outline and generally multiple These characteristics usually suffice to make the situation clear

A collection of debris a piece of slough or blood clot may create the passing impression of a stone but the general appearance and if necessary the consistence on probing will serve to identify such a mass

It is possible to overlook a vesical calculus during cystoscopy if it is hidden from view by a large median lobe of the prostate or it may even be concealed in a marked recess at the bladder base which must be carefully searched Again it is important to examine the apex of the bladder for sometimes a stone is grasped by and suspended from the upper part of the vesical cavity which has contracted upon it On the other hand the stone may be concealed because it lies completely within a diverticulum

A turbid or blood stained medium may prevent a satisfactory cystoscopy and cause uncertainty about the presence or features of vesical calculi This may necessitate a second cystoscopy after suitable lavage Radiography may be required to reveal calculi in these circumstances

STATE OF THE BLADDER—It is important to have information on this point before the treatment is decided The presence of a diverticulum marked cystitis an intravesical projection of the prostate or a bladder growth all contraindicate litholapaxy

Sounding the bladder—The instrument used for this purpose has a shorter beak than the type of instrument in common use for dilatation of urethral stricture Although this means is not commonly used since the advent of cystoscopy yet it can give some valuable information On the other hand it has disadvantages which make it untrustworthy as the sole means of determining the presence of vesical calculus for instance calculi which are small light or guarded by a projecting prostate or a diverticulum may escape detection the method gives no information about the condition of the bladder walls On the other hand an opinion may be formed on the consistence of the stone by noting the kind of impact the size may be roughly estimated by observing the length of the shaft that must be withdrawn during the time which the sound remains in contact with the stone the presence of multiple stone is indicated when contact is noted first on one side and then the other

Exploration with a sound is contraindicated in the following circumstances when there is pronounced cystitis when hæmaturia is an outstanding feature in a patient suffering from urinary fever or who is known to react badly to the passage of an instrument when urinary tuberculosis is present

A general anæsthetic is necessary in children but not usually in adults About 6 oz. of lotion are injected through a catheter into the bladder after which the sound is introduced On entering the bladder the tip of the instrument is kept directly upwards and is pushed onwards until it comes into contact with the posterior wall After turning the beak laterally the lower part of one lateral wall is explored by withdrawing with the handle towards the opposite side until contact with the internal urinary meatus is made The same procedure is then repeated on the other side

The floor is explored in much the same way but by keeping the shaft nearer the mid line The upper part of the bladder is investigated by

depressing the handle while the beak is directed upwards. To explore a retro prostatic pouch the beak must be directed towards the base by raising the handle which is then turned over. The greater part of the vesical mucosa can thus be explored by a systematic tapping in the different regions. The sensations to the hand and ear of the impact of the stone on the instrument are unmistakable in most cases.

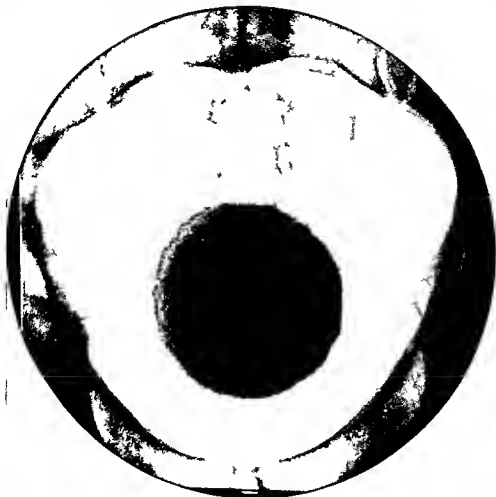


FIG. 442

Vesical calculus which weighed 1 lb. 10 oz. in a man aged 30 who complained of a dull ache at the end of micturition. (Mr. Hugh Lett's case.)

**Rectal or vaginal examination**—Combining one of these methods with abdominal palpation will sometimes enable even a small stone to be discovered in a female. In the male the bimanual method is quite unreliable unless the stone is a large one. The same may be said of a simple rectal examination but when a large stone is present and when there is thickening at the bladder base from prostaticitis the impression may be created that there is a carcinoma in this vicinity. On the whole these methods of examination for stone must be considered inadequate.

**Radiography**—The great majority of vesical calculi can be revealed by this means. At the same time an important proportion are not detected by this method. Stones varying in size from a marble to a hen's egg and con-

sisting largely or entirely of uric acid or ammonium urate have failed to show on good X ray films. Calculi associated with enlarged prostates are specially liable to be overlooked. Cabot (1936) quotes another writer who says that 51 per cent of fifty seven cases failed to show a shadow. A negative X ray cannot therefore be accepted as proof that a vesical calculus is not present. On the other hand the method has its value in being the only one which can reveal a stone which is hidden within a diverticulum or in a deep recess behind the trigone.

There is less chance of a calculus not being revealed if the film is exposed with the bladder empty this is more important when the urine is dirty.

Sometimes a radiogram will display a foreign body as the nucleus of a stone. It is useful to be able to demonstrate a stone in this way in the presence

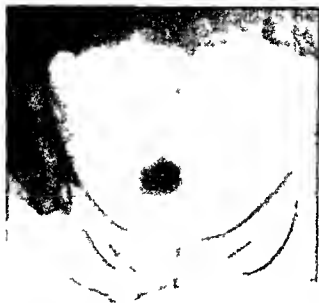


FIG. 443

Vesical calculus and calculi in prostate in a patient aged 53

of urethral stricture or when instrumentation is difficult from some other cause. Different appearances of vesical calculi can be studied in Figs. 442 to 447.

The shadows of phleboliths, calcified glands, calcified uterine fibroids, etc. (Fig. 446) must be studied in order to differentiate these from vesical calculi. The features of an incrustated tumour must also be recognized.

### PROGNOSIS

The prospects of cure either by litholapaxy or by suprapubic incision in the majority of cases are very good. On the other hand where the kidneys are already damaged the danger that infection which is so often well established in the bladder will be lit up and will involve the kidneys and precipitate a state of anuria is quite considerable even when the intervention is not severe. The outlook from such a complication is always grave.

The prognosis therefore may be said to depend upon the state of the kidneys and the existence or absence of infection in the bladder.



FIG 444

Two vesical calculi. Note the lesser density of the outer than of the inner portion of the larger stone. Also note that the prostatic region is faintly outlined with calculi. The patient was aged 53 and suffered from urethral stricture.



FIG 445

Multiple vesical calculi (Mr. Hugh Lett's case)

## TREATMENT

Whatever virtues may be possessed by so called stone solvents they are not capable of reducing the size of a stone from one which is too big to pass

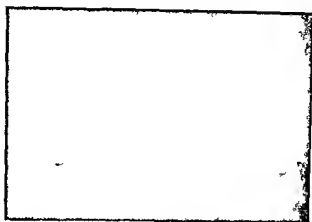


FIG 446

A radiogram of a calcified uterine fibroid. The position, size and shape of the shadow are all compatible with vesical calculus.

to one which is small enough to escape per urethram. Surgical intervention is the only remedy in such a case.

When renal and vesical calculi exist together and the stones in both situations require removal surgically the kidney condition should be dealt with first. This is because there is a greater danger of serious renal infective complications supervening from operating on the bladder first.

Small stones may be left under observation for a short time with the prospect that they will pass spontaneously. Sometimes especially in women this expectation is realized after dilating the urethra or even following a cystoscopic examination. In other cases the stone can be removed by means of the cystoscopic rongeur forceps (Fig 447). When a stone is too large

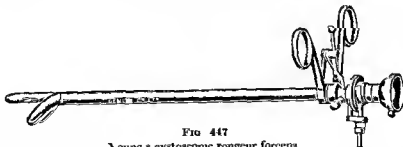


FIG 447

Young's cystoscopic rongeur forceps

to be dealt with in this way it must be removed by crushing it and evacuating the fragments (litholapaxy) or through an incision into the bladder (lithotomy).

There is the great advantage of litholapaxy over lithotomy that as a rule it need not keep the patient in bed for more than a few days, whereas it is

generally a matter of weeks before the patient can start to move about after lithotomy. However there are many circumstances which contraindicate the crushing operation.

Open operation is indicated where removal of the stone is necessary but where litholapaxy is inadvisable. As specified below in discussing the contra indications to litholapaxy some of these conditions require the bladder to be opened and the stone is removed at the same time.

Removal of the stone by either method should not be undertaken under the following conditions where there is some other but more serious malady in which the prognosis is grave in certain cases with bad chronic pyelonephritis in elderly men with chronic urinary cachexia who would not survive intervention. Only for the relief of violent pain would it be justifiable to intervene surgically in the above cases.

**Litholapaxy**—This procedure grew up and reached its important place in surgery at a time when stone was quite common in young people who acquired their lithiasis as a result of a poor standard of living. To day those circumstances hardly exist in this part of the world. The result is that most cases of vesical calculus are met with in patients past middle life who are developing bladder neck obstruction from one cause or another as indicated by the presence of residual urine in the bladder. The indication in all such cases is to deal with the obstruction as well as to remove the stone, and where the bladder has to be opened as in prostatectomy the stone is removed at the same time. There are other reasons (stated below) which make litholapaxy an undesirable procedure.

**MORTALITY FROM LITHOLAPAXY**—Those who have had opportunities of a great experience in Eastern countries have been able to show extremely low mortality rates. Freyer (1901) 1.8 per cent from 610 Indian patients and 7.72 per cent from 776 patients in England. He attributed the difference in results to the fact that many of his English patients suffered from prostatic enlargement.

Watson and Cunningham (1908) collected 17,736 cases which showed a mortality of 2.4 per cent.

#### CONTRA INDICATIONS TO LITHOLAPAXY —

- A large stone
- A moderately large oxalate stone,
- When prostatectomy is indicated
- Vesical diverticulum
- Bladder growth
- Marked cystitis,
- A contracted bladder
- An advanced urethral stricture
- Stomach in prostatic cavity following prostatectomy
- Certain foreign bodies
- Serious renal disease

It may be a prolonged affair to crush a large calculus or a moderately large oxalate calculus. Trauma to the bladder wall must necessarily be important in such cases, moreover infection and kidney damage must be present in some degree in these circumstances.

With an enlarged prostate considerable trauma to the gland at the neck of the bladder with consequent bleeding is likely. The treatment of the prostate in any case generally requires the bladder to be opened.



When a diverticulum is present fragments from the lithotripsy are certain to enter the sac

Lithotripsy with a bladder growth present will cause serious hæmorrhage. When severe cystitis is present not only is bleeding inevitable in proportion to the infection but the latter will become increased and so will the danger of infective complications

A contracted bladder offers the increased danger of trauma together with the risk of stirring up the infection which has produced the contraction

A urethral stricture if advanced is not only apt to become worse as a result of trauma to this locality but perurethral abscess and fistula are likely to occur

If a stone in the prostatic cavity can be pushed back into the bladder with a sound it can be crushed otherwise the bladder should be opened. When a stone envelops a foreign body litholapaxy can be carried out only when the latter is of soft consistence and can be removed per urethram

If the kidneys are the seat of marked sclerosis or infection it is better to remove the stone by open operation rather than by litholapaxy because of the danger of stirring up renal sepsis

**THE LITHOTRITE**—This instrument is made in sizes which range from 10 to 32 Charrière (4 to 18 English scale) to meet the varying requirements according to the age of the patient and nature of the stone. With the smallest instrument it is possible to crush a stone in a child under 2 years of age

The appliance consists of two principal parts on each of which is a blade which grips the stone during the crushing process (Fig. 448). The outer or

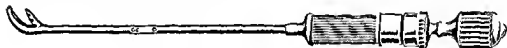


FIG. 448  
Freyer's lithotrite

female blade is continuous through its own shaft with the handle which is the thick portion to be gripped by the left hand of the surgeon. The inner or male portion is surmounted by a wheel or cone which the surgeon manipulates with his right hand while the stone is being crushed. The wheel is a characteristic of the Thompson lithotrite while the cone is a feature of the Bigelow. In cases likely to require prolonged crushing the latter gives the better mechanical advantage and is therefore quicker and less fatiguing for the surgeon to use

The two blades are locked together by means of either a button on the handle in the Thompson instrument or a screw cap on the male blade in the Bigelow. The best features of these two instruments have been combined in the Freyer lithotrite (Fig. 448)

The size of instrument chosen for any given case should be the one that can be passed and manipulated comfortably in the urethra. Speaking in a general way it may be said that the larger the size of the instrument that can be introduced the better. For this reason preliminary dilatation of the urethra with metal bougies is often an advantage. In children this should be a routine. From the age of 2 years onwards a dilatation from 15 to 18 Charrière should always first be obtained. This as a rule will enable an instrument with its largest diameter of 14 to 16 Charrière to be used com-

fortably In children no force must be used in the dilatation of which the limit of safety must be recognized by touch when it is reached

Certain lithotrites have been designed which combine a cystoscope with a lithotrite As some of the thickness of the shaft has to provide a way for the telescope there has resulted a sacrifice of strength in the instrument Therefore in order to avoid the danger of applying an amount of force which the instrument is not constructed to stand the wheel which controls the movements of the male blade is placed not at the top but at the side of the shaft Such an instrument should not be used for large or hard stones Its chief use is in dealing with certain small stones which are not easy to grasp with an ordinary lithotrite or when there is some difficulty in gripping some of the smaller fragments towards the conclusion of a crushing operation

**THE TECHNIQUE OF LITHOLAPAXY**—The position of the patient is the dorsal decubitus with the table horizontal and the thighs well abducted to allow for a wide range of movement for the handle of the lithotrite The operator stands on the right side of the patient If the table is not one that can be lowered or raised to suit the operator a stool on which to stand of about 4 in in height may be a great convenience during the course of a prolonged crushing This will enable him to exercise his full force to the best advantage The degree of anæsthesia obtained is of the first importance the operation should not proceed until a good depth of narcosis is established Spinal or sacral anæsthesia commands an important place for litholapaxy because the bladder reflexes can be completely abolished by these means Litholapaxy under local anæsthesia should only be attempted when a very small stone is to be crushed by employing a cystoscopic lithotrite

*The filling of the bladder*—A catheter is introduced and after washing out the bladder thoroughly 4 to 6 oz of normal saline are left in this amount is all that is necessary Too much fluid makes the fragments more difficult to collect between the blades because then the interior of the bladder becomes so capacious that the pieces of stone may just as easily fall to one or other side of the blades instead of between them Care should be taken not to over distend a bladder which is intolerant of more than small quantities of fluid for herein lies a serious danger of rupture It is better to fill the bladder from a syringe (Fig 129) than from an irrigating reservoir so that a thorough check can be kept upon the quantity of fluid that the bladder contains at a given time

*The introduction and manipulation of the lithotrite*—Before introducing the instrument it is frequently essential to enlarge the external urinary meatus Sounds are next passed if necessary It is then wise to introduce a cystoscope to ascertain the size of the stone if recent information on this point is not to hand

Before inserting the lithotrite the blades should be locked the beak well lubricated and the instrument held as a scalpel with the beak directed downwards After entering the urethra the beak is kept in contact with the roof and when it is felt to engage the membranous urethra the instrument is moved from the vertical to the horizontal This sweep should take the beak into the bladder Before the blades are opened to seek the stone care should be taken to see that these are actually in the bladder and not merely in the posterior urethra which may be so dilated as to create this false impression If the movement of the beak is restricted when it is rotated it is not in the bladder, also in an adult if the shaft has not an in and out excursion of at least 2 in in the horizontal position, it is most likely not in the bladder

The position of the patient encourages the stone to fall into the most

dependent part of the bladder in the mid line behind the trigone. If the calculus is not resting in this position it will be very near to it and the movements of the fluid caused by the opening and closing of the blades will induce the calculus to fall between the jaws if these are in the right position.

By keeping the female blade pressed gently on to the floor the interior of the bladder becomes cone shaped with the apex of the cone downwards where the blades lie. While the blades are still closed the beak is turned slightly from the stone so that the opening of these will not push the latter away, then on returning them to the upward position a gentle shake of the whole instrument should cause the calculus to rest within its jaws. Often the mere firm downward pressure of the female blade is sufficient to accomplish this. The sensation to the hands of a gripped stone is unmistakable—the crushing should not proceed until this is recognized—then the instrument is locked and screwed down and the process repeated.

As the crushing continues some of the fragments still to be reduced lie to one or other side of the blades and can be got into position by merely opening and closing these and without any rotation of the beak or by slight movements of the handle up and down or to one side or the other. In a normal bladder there is no need to turn the beak downwards to search for fragments. Unless the bladder has been over distended the fragments will fall between the jaws if the female blade is kept in its proper position. If however owing to the presence of a recess behind the trigone there is difficulty in grasping the stone the blades while pointing upwards should be opened and then turned over and the stone gently sought.

In a pouched or trabeculated bladder there is a special danger of gripping the mucosa with the lithotrite. When it is felt that something is gripped its consistence should be investigated by withdrawing and then closing the male blade which is allowed to drop on to the object grasped and the nature of the impact will then at once make it clear whether it is stone or mucosa that is held.

As soon as the fragment has been locked in the jaws it is as well to lift the female blade just clear of the bladder floor to avoid injury to this part from the debris which is forced through the outer fenestrated blade.

When the lower segment of the bladder is narrow the stone may be above the instrument. To catch the stone the following manipulations should be carried out: lower handle between thighs to long axis of body, open jaws very wide, depress handle further, close and fasten, move blades from side to side and backwards and forwards to be sure the bladder is not caught.

As an excess of small debris may interfere with the crushing this should be evacuated from time to time. Before the withdrawal of the blades these must be completely closed otherwise laceration of the urethra is likely to follow.

In India (Betts 1924) 10 per cent. of bladder stones cannot be dealt with by simple crushing owing to their size and hardness. Some large stones which are not hard often without locking the lithotrite can be broken up by a sharp tap on the end of the instrument with a wooden mallet. The lithotrite with the stone is lifted from the floor of the bladder and if necessary a series of taps are made. As the blades are not locked there may be some difficulty in keeping the stone within the jaws therefore the male blade must be fixed with the left hand. Anthony (1925) devised a size 16 (Charrière 28) lithotrite in which the stone is kept gripped by means of a spring and which has an anvil head suitable for a blow with a hammer.

*The evacuation of the fragments*—The evacuating apparatus consists of a cannula and an aspirator (Figs 449 and 450). The cannula is a metal tube with a short coude beak and a large eye at the junction of the beak and the



FIG 449  
Evacuating cannula

shaft. The cannula is armed with a stylette which carries an obturator, the last blocks the eye, which can be freed during evacuation by inserting the stylette when necessary. The vertical fin near the distal end of the cannula indicates the direction in which the beak is pointing. The aspirator is a hollow rubber bulb which opens into a glass bulb below and the cannula in front and is detachable from both of these. The communication between the bulb and the cannula is controlled by a tap.

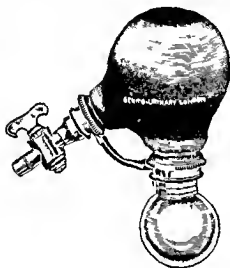


FIG 450  
Freyer's evacuator

In the Bigelow apparatus there is a stopcock near the outer end of the cannula and another one on a tube which leads from the top of the rubber bulb and through which fluid can be sucked from a receptacle at the side of the table. After fitting the evacuator into the cannula, the tap is opened, allowing a free passage between the two. There are several modifications of the original Bigelow's aspirator. Freyer's is probably the best.

When the crushing is considered to be finished the largest cannula that the urethra will take is passed and the bladder contents allowed to escape. From 4 to

6 oz. of fluid are again introduced and the aspirator also filled with fluid and with its tap closed is fitted on to the cannula. The tap is now opened while the beak of the cannula is kept on the base of the bladder and the bulb is slowly compressed. As the bulb expands the returning fluid brings with it a mass of sand and stone fragments which can be seen tumbling into the glass bulb. The process is repeated with the beak of the cannula still in the same position until the stone detritus ceases to be returned. With the Bigelow apparatus any air which passes from the bladder into the upper bulb is allowed to escape by opening the uppermost cock and compressing the bulb.

The vesical mucosa may be drawn into, and may block the eye during the aspirating process. This accident may be suspected when the fluid suddenly ceases to return, but it can be instantly remedied by applying pressure to the bulb. Blockage of the cannula from stone fragments may sometimes be relieved in the same way, but often requires the passage of the stylette to free the channel again. If the eye is kept buried among the small fragments at the base of the bladder it may continually become blocked. It is therefore expedient to keep the eye elevated until the bulk of the debris is evacuated.

In a long case it saves a good deal of time to have two aspirating bulbs

in use rather than have to wait until the single bulb is unscrewed emptied and refilled. As the fluid returning into the bulb becomes finally free from debris in order to determine that the whole stone has been completely crushed the operator should listen carefully for a clicking sound which the contact of a fragment would make with the beak of the cannula as the aspirating process is continued.

The search for particles must be carried out by moving the beak into the various parts of the bladder base.

Small stone fragments left in the bladder may be passed per urethram or may form the nuclei of fresh calculi.

Blood clot in the presence of many fragments of stone may cause the latter to form a single calculous mass rather than a number of fresh stones.

At the end of the operation an indwelling catheter should always be employed for forty eight hours. This will enable twice daily irrigation of the bladder to be carried out with a weak antiseptic such as 2 per cent. boracic lotion or 1 in 10 000 silver nitrate or if there is a danger of clots with normal saline. If there is any pyrexia when the catheter is removed the patient is kept in bed until this is settled. Generally the patient can get up on the fourth day. Copious fluids are taken during the convalescence.

**MEDIAN PERINEAL LITHOLAPAXY**—This is recommended by Betts (1924) when a stone is too large or hard to be crushed in the ordinary way. The patient is placed in the lithotomy position and after filling the bladder the urethra is opened in the perineum onto a grooved staff. The lithotrite is inserted through this incision. The perineal wound generally heals quickly. It will be wiser for most operators to remove this type of stone by opening the bladder above the pubis.

**LITHOLAPAXY IN WOMEN**—On account of the shortness of the female urethra litholapaxy is generally simpler in women than in men. Large sized instruments are easily introduced and there is a good range of movement for the manipulation while the fragments do not have to be reduced to such a small size for evacuation. On the other hand it is difficult to maintain the full distension of the bladder during the crushing as the fluid tends to escape along the outside of the instrument. This is most noticeable during evacuation when pressure on the bulb is made and makes the process prolonged and tedious. To counteract this tendency the largest possible cannula should be employed. Pavyon, Desnos and Minet (1922) as a result of their experience of litholapaxy in ninety women recommend sizes 30 to 34 Charrriere as the most suitable and as an additional means of coping with the escaping fluid place a thick rubber ring round the instrument where this leaves the external urinary meatus. Pressure kept up by an assistant with a gauze pad on the under aspect of the urethra and maintained during the crushing is often quite satisfactory.

**COMPLICATIONS OF LITHOLAPAXY**—*Encountering a foreign body*—This may occur during the lithotrity quite unexpectedly. If the object is one whose nature is uncertain the lithotrity should give place to cystoscopy. If it is then discovered that the object is unsuitable for removal by litholapaxy this must be abandoned and the removal should proceed through a suprapubic incision.

*Failure to find a stone*—This should at once raise the question as to whether too much fluid has been introduced and if there is any doubt the point must be settled by emptying and refilling the bladder. A long continued contraction of the part of the bladder surrounding the stone and the disappearance of the calculus into a diverticulum are causes of difficulty in other cases. But

these possibilities should be discovered before litholapaxy is undertaken. Any tendency to spasm of the bladder is almost always overcome when the proper depth of anesthesia is obtained. A cystoscope should always be introduced and the bladder examined if a stone which has been known to exist cannot be found.

*Injury to the bladder wall by crushing between the blades occurs under two sets of circumstances*—when the bladder is not sufficiently distended and when the bladder is searched for final stone fragments by opening and closing the blades in different parts of the bladder. The bladder is not as a rule perforated completely but as a result of laceration pericystitis or peritonitis are likely to occur nevertheless.

*Leaving behind fragments of calculi*—This is apt to occur if there is too much fluid in the bladder when evacuation is carried out. The mistake is easy to remedy by emptying the bladder and re-injecting only 2 oz. The larger the quantity of fluid in the bladder the less distance from the beak of the instrument does the suction action of the aspirator extend so that if this procedure is carried out with a distended bladder the fragments instead of lying grouped together about the end of the cannula are scattered widely over the bladder floor. It is a wise routine to employ cystoscopy either at the end of the litholapaxy or a week or so later to make sure that the bladder is free of fragments.

*Rupture of the bladder from over distension*—This is likely to occur if more fluid is forced in with the aspirator bulb when the bladder is already filled to the limit of its capacity. Atrophy in places and a generalized lack of elasticity of the bladder wall are not uncommon when a stone is present and may easily predispose to the complication just mentioned. That this accident has happened is obvious when it is found that there is a good deal less fluid returning to the aspirator than has been introduced. In those circumstances a suprapubic incision must be made.

After the bladder is ruptured urine slowly extravasated into the pelvic cellular tissue may gradually extend upwards on one or both sides of the posterior abdominal wall until it reaches kidney level. Bladder urine has been found extending upwards from the pelvic floor so as to completely surround one kidney. After rupture has occurred if no fluid is found in the prevesical tissues the abdomen must be opened, the fluid mopped out of the pouch of Douglas and the bladder rent sutured in two layers. If the urine is infected a rubber drain should be placed in position passing to the pelvic floor. Suprapubic bladder drainage must also be established. If fluid is found in the prevesical space not only should the bladder be opened and drained but free drainage must be provided for the space of Retzius and bladder base along the path of ascent that the fluid has followed.

*Difficulty in evacuation*—This is caused by the presence of air in the evacuator or bladder. Both the glass and the rubber bulbs should be wholly occupied with lotion. If air is present it is indicated by inverting the glass bulb when it will rise to the surface. Pressure on the evacuator when it contains a lot of air fails to create the requisite amount of suction to aspirate the fragments. The influx of air through the cannula will occur if the end of the latter instrument is not blocked with a finger just before the fluid has ceased to escape while the bladder is being emptied. Air already present in the bladder may be evacuated by firm pressure over the bladder while the fluid is flowing through the cannula. Fragments which have entered a diverticulum as a rule will require to be removed through a suprapubic cystostomy incision. Fragments in a prostatic cavity resulting from prostatectomy or

in a dilated posterior urethra can as a rule be safely evacuated if due care is used

*Hæmorrhage* is rarely copious enough to prevent cystoscopy at the end of the operation but litholapaxy carried out in the presence of an adenomatous enlargement of the prostate is bound to cause a free flow of blood. If the patient is still bleeding at the end of the operation a catheter should be tied in and the bladder irrigated every ten minutes with saline till the bleeding has stopped. If at an early stage post operatively the indwelling catheter becomes blocked with clot it may be possible to remedy this by changing the catheter or to free the block by suction with a Thompson's bladder syringe. If this fails an anæsthetic will be required and the bladder can be freed of clot by using the evacuator. If however there is a marked degree of retention there is a danger of rupturing the bladder by using this method in which circumstances the clot must be cleared out by opening the bladder.

*Epididymitis*—This may result from trauma to the posterior urethra. Once this form of inflammation has set in suppurating epididymitis is not unlikely and abscess formation will require incision and drainage.

*Periurethral abscess*—This is quite likely to occur when litholapaxy has been carried out in the presence of a urethral stricture especially if the latter has been subjected to forcible dilatation in order to admit the lithotrite.

*Extravasation of urine* may also occur as a complication of the periurethral infection. This will require more liberal incisions into the scrotal and perineal tissues.

*Pyelonephritis*—This is not unlikely when a stone is large because in such circumstances the kidneys are already damaged and the manipulations will be necessarily somewhat protracted. Where such conditions are likely to apply it is better to consider that litholapaxy is contraindicated.

*Urinary fever*—This may occur with metastatic foci in different parts of the body where the manipulations are prolonged especially in a case where there are chronic inflammatory or fibrous changes in the prostate.

*Suprapubic lithotomy*—This is the procedure that should be followed in all operable cases where periurethral methods of removal are unsuitable. The conditions given as contraindications to litholapaxy will therefore necessitate suprapubic lithotomy if removal of the stone is indicated. Pre operative investigation and preparations are essential in all cases. An indwelling catheter for forty eight hours with twice daily vesical irrigations before operation will benefit the patient under the following conditions: the urine is blood stained or dirty the blood urea is raised there is renal tenderness.

General spinal or epidural anæsthesia may be used according to choice. Under modern conditions it is difficult to find any objection to gas and oxygen administration it is even doubtful if infiltration anæsthesia of the abdominal wall in bad cases has any advantage to offer over this method.

The size of the wound made in the bladder must be in accordance with the size of the stone to be removed. When the calculus is a large one an ample incision must be provided both in the parietes and in the bladder. If a large stone is dragged with difficulty through an inadequate incision the prognosis of the case may be seriously altered.

Most vesical calculi are conveniently removed by means of a lithotomy scoop the stone is grasped between the bowl of the scoop and the index finger in some cases a lithotomy forceps is more convenient.

Small stones are easily removed with the fingers. With a calculus of considerable size it is first essential to be sure that the stone is everywhere detached

from the bladder wall before any attempt is made to deliver it. The fingers are gently passed round it to ensure its complete detachment. Any stone which is too large to grasp with the forceps should be levered out by a scoop, which is passed beneath it.

When a calculus occurs in a diverticulum the sac should be excised with the stone in its interior. As infection is generally conspicuous in a case of this kind it is often wise to give a period of suprapubic drainage before excising the diverticulum.

For treatment of vesico-urethral calculus, see p. 954.

Lateral lithotomy and vaginal lithotomy need only be mentioned to say that they are now operations of a bygone age.

H. P. WINSBURY-WHITE.

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## CHAPTER LXXXII

### URETHRAL CALCULI · PREPUTIAL CALCULI

#### URETHRAL CALCULI

**C**ALCULI occur less commonly in the urethra than in any of the three other principal localities of the urinary tract. In my own series of 665 cases of stone in the urinary tract they form only 2.8 per cent (see page 885).

As in renal calculus the period of maximum incidence is the fourth decade of life.

In this part of the world urethral calculus has diminished. This is largely because the incidence of vesical calculus has fallen. Formerly cases commonly occurred from the earliest infancy onwards. Englisch (1904) showed that a far greater number of urinary concretions entered the urethra during the first two years than during any subsequent similar period to the end of the first decade. This relative frequency of urethral stone in very young children is due to the fact that the internal vesical sphincter is not so contracted in early as in later years.

It is convenient to consider periurethral in conjunction with urethral calculi.

#### URETHRAL CALCULI IN THE MALE

**Ætiology**—The most practical way of classifying urethral calculi is according to whether they have been merely arrested in their passage from above or whether they have originated in the urethra. The great majority of urethral calculi undoubtedly fall into the former category, having come from the upper urinary passages, the bladder or the prostate. The importance of local factors in the urethra which predispose to stone in this situation is emphasized in a report on a series of urethral calculus cases by Debenham (1930). This showed that five patients were admitted on more than one occasion with the same condition.

Once in the urethra the passage of the calculus is likely to be obstructed if not by an abnormal narrowing by a normal one. The situations where arrest commonly takes place are the prostatic urethra, the bulbous urethra and the navicular fossa. In my own cases 55 per cent were in the prostatic urethra. Of the local predisposing conditions urethral stricture is the most important. Stricture acts not merely by obstructing the passage of a stone from above but also by giving rise to dilatation and infection in the urethra behind the point of narrowing. Abscess formation in the urethral wall leading to a pocket of considerable size sometimes occurs.

Periurethral suppuration arising quite independently of stricture predisposes in the same way to stone in the pocket thus formed.

Urethral diverticula of congenital origin also play an important part as stones may easily form in such pockets where urine can enter freely.

**Pathological anatomy**—The portion of the channel in contact with the stone becomes dilated, reddened, oedematous and often ulcerated from pressure.

and infection. Periuethral inflammation may proceed to abscess formation and urinary fistula through which the stone may escape. The periurethral abscess on the other hand may burst into the urethra and result in extravasation of urine. The urethra above the stone tends to become dilated from back pressure.

The stones which form in periurethral sacs are single or multiple and owe their origin to the fact that they lie in a blind recess which opens into the urethra by a small orifice through which urine can enter and from which drainage is imperfect. Once calculus formation in such a pocket has begun both the recess and its contents slowly increase in size sometimes with the result that a large number of stones are formed or a single calculus arises of considerable bulk.

**CHEMICAL COMPOSITION OF URETHRAL CALCULI**—As these are stones which have largely passed from above they have no chemical features which distinguish them from other urinary calculi. Oxalate stones having a rough exterior are more likely to become impacted than those consisting of uric acid or urates.

**VOLUME**—Time is the chief factor which determines the size that a calculus may ultimately attain. Numerous cases have been reported in which the stone was known to be present for many years and has attained considerable proportions as a result of the constant deposition of crystals from the urine. In one case (Clark 1912) a stone 3 in. long was removed by external urethrotomy from a man who had been conscious of a lump in the penis for twenty five years.

**NUMBER**—This may vary from one to a hundred or more but as a rule there is a single stone present.

**CONFIGURATION**—Stones which have recently arrived from above are rounded oval or elongated with surfaces which are smooth or rough with projecting crystals. Fragments resulting from recent lithotomy are irregular in shape with freshly broken surfaces bordered by sharp edges. Stones which have remained for long periods in the urethra gradually acquire the shape of the passage / that is to say they tend to be elongated with swellings and narrowings according to the locality. Sometimes along one side there is a gutter formed by the urinary stream.

A stone in the prostatic urethra tends to become hour glass in shape. This configuration results from the backward growth of the stone which ultimately projects through the internal urinary meatus into the bladder (Fig. 451).

In the bulbous urethra a stone assumes a spindle or club shaped appearance.

Multiple stones may make contact by closely fitting facets which permit of a certain degree of movement at the different joints. So accurately may the various components of the calculous mass fit together and so moulded by the urethral walls may the whole become that a perfect cast of the bulk of the urethra results.

**Symptoms and signs**—The complaints which the patient makes may vary considerably according to circumstances. An attack of renal colic or lithotomy sometimes precedes the local symptoms. The initial sign is likely to be a sudden urethral pain and arrest of the stream during micturition resulting in complete retention of urine or considerable effort may cause the escape of a few drops or even of the stone.

When complete retention does not occur or when this passes off spontaneously the urethra becomes strikingly tolerant towards the stone and there may be little interference with micturition. This state of affairs may

continue for years. Difficulty of micturition may be an early symptom or may gradually supervene, and the patient often learns to manipulate the stone so as to facilitate the act. A chronic urethral discharge in some degree is not unusual, this tends to be blood stained from time to time. Painful and frequent micturition gradually supervene, while in some cases incontinence of urine becomes a feature.

The tolerance which can be acquired to the presence of a calculus is a feature of a few recorded cases. Some of these give periods of many years. One case actually gave a history going back for fifty three years (Hirsch 1922).

On palpation the stone can sometimes be felt along the course of the canal, or it may be obscured by periurethral thickening and, finally more advanced periurethral changes are to be noted.

With periurethral calculi obstruction to micturition or the passage of instruments seldom occurs. A single calculus or a number of calculi may be readily palpable superficially to the urethra.

**Diagnosis**—The sudden onset of acute retention and urethral pain should lead to local investigation which in its turn ought to establish the diagnosis. A previous history of renal colic will also be a help. In the more chronic cases it may quite well be that a stone is discovered in the course of an investigation of the urethra because of symptoms and signs which do not necessarily suggest the presence of a stone.

Rectal examination may reveal a centrally placed thickened and tender area in the prostatic region, or the stone may be easily palpable in another part of the urethra. The passage of a catheter or a bougie is likely to render the most characteristic evidence. Obstruction by a hard object may be at once appreciable or there is a characteristic grating sensation as the instrument passes over the stone. Sometimes a doubt remains after these procedures, urethroscopy, if this is possible, will settle the point. Radiography is a certain and simple means of diagnosis.

**Treatment**—The smaller stones should be grasped and removed under direct vision by means of the proper forceps, introduced through an operating urethroscope. The urethra is first carefully anesthetized by the installation of 4 per cent novocaine, or other suitable anæsthetic (see p 646) the urethroscope introduced and the stone observed. It is first ascertained that the calculus is not too large to lend itself to this form of treatment, and, secondly it must be made certain that its whole bulk is within the urethra for if it is merely projecting into the lumen from a pocket which lies in its floor, or if part of the stone protrudes through the internal meatus into the bladder, this method of treatment will not succeed. Therefore in certain cases a radiogram may be necessary before this point is decided. The stone is firmly grasped in the jaws of the forceps, its mobility is demonstrated and while maintaining a firm grip on the calculus the whole instrument is withdrawn, if a secure hold cannot at first be obtained several attempts may be necessary before these manipulations succeed. Owing to the danger of air embolism should urethral bleeding occur these procedures must never be attempted through an aëro urethroscope. If the special instruments necessary for carrying out these measures are not available and the stone lies in the anterior urethra provided information as to size and extent has been obtained by radiogram or other means an attempt to grasp the calculus with lithotomy or with alligator forceps may be made. It will probably save time not to attempt this without a general anæsthetic. With this means, if the stone is palpable in the anterior urethra, it can sometimes be worked forward right out of the urethra by manipulating it from the outside.

A method has been described in which the removal can be accomplished by means of a number of filiform bougies, as many as possible of these are introduced, so that they pass beyond and thus surround the stone. Traction is then made on all the bougies together and the calculus may then come away in the firm grasp of the encircling instruments.

If other means have failed or are not at hand, a bent probe introduced past the stone with the object of hooking it forward is sometimes successful.

In all of these methods in which the stone is forcibly withdrawn, the introduction into the urethra of a little glycerine or other lubricant will be found a material advantage in assisting the passage.

If the calculus is too large to be dealt with in any of the above ways, the line of treatment to be followed will depend on the situation of the concretion.

In the navicular fossa a simple meatotomy will, in most cases, enable the stone to be grasped and removed by a pair of suitable forceps, or it may be necessary to extend the incision some distance along the floor of the fossa, and this can be quite satisfactorily carried out under a local anæsthetic.

When the calculus is further back in the anterior urethra and it cannot be grasped or worked forward, it will be necessary to perform external urethrotomy in order to deliver the stone. The wound should heal quite straightforwardly in an uncomplicated case after suturing the urethra with fine catgut, it is not necessary to use an indwelling catheter.

WHEN A STRICTURE IS PRESENT—Attention should at once be directed towards treatment of the stricture. When this is fully dilated the stone will probably pass spontaneously. Such treatment depends, however, on whether instruments can be made to pass both the stricture and the stone. Internal urethrotomy is sometimes the proper procedure. When instrumentation does not succeed, or when local inflammatory complications are present, external urethrotomy is necessary.

**CALCULUS IN THE PROSTATIC URETHRA**—A radiogram should be carefully studied to ascertain the size, shape and disposition of the stone. If this is considered to be small and to lie wholly within the prostatic urethra, it may be conveniently removed through an operating urethroscope. If the stone is too large for this method under a general spinal or a sacral anæsthetic, with a large metal sound an attempt should be made to dislodge the stone into the bladder, where it can be easily crushed with a lithotrite.

If the calculus is too large, or is held firmly by the surrounding parts, continued attempts to return it to the bladder with a sound can only be successful as a result of considerable injury to the internal meatus and the prostatic urethra, and in such circumstances must be discontinued. A constriction involving the middle of the stone, which is visible on a radiogram, indicates that the calculus is gripped by the internal meatus, and that open operation is the method of treatment. The same course must be followed if the stone is partly buried in the prostate or projects forward through the membranous urethra.

In removing a stone from the prostatic urethra by operation, the perineal route should be followed when the calculus extends into the membranous urethra, and the suprapubic route when the stone projects into the bladder. As a rule it will be found easier, when operating through the perineum on the latter type of case, to push the calculus backwards into the bladder and then to crush it with a lithotrite which is introduced through the operation wound, considerable tearing and bruising will result from an attempt to drag the vesical stone through the constricting sphincter. In removing a large stone by the suprapubic route the forefinger can be introduced into the internal

urinary meatus which is gradually stretched so that the whole of the stone can be encircled and freed

**PERIURETHRAL CALCULI**—There may be many stones lying in a large sac opening into the floor of the urethra. For calculi situated anywhere in front of the prostate the patient is placed in the lithotomy position. After pulling the scrotum forwards or backwards as the case requires an incision is made over the swelling the sac and its contents are then dissected out and its connection with the floor of the urethra identified and severed. The urethral



FIG 451

Prostatic calculi while in the bladder is a mushroom calculus the stem of which occupies the posterior urethra in a patient aged 39

wound is next restored with fine catgut over a metal bougie previously passed into the bladder to make sure that there is no remaining obstruction (For prostatic calculi see p 576)

When a single large pocket containing one or more stones is present and this communicates with the posterior urethra through a suprapubic approach, the orifice of the sac can usually be felt by passing the tip of the forefinger through the internal meatus. The bladder mucosa overlying the stones should be split up right into the orifice of the sac and the edges of the incision held apart while its interior is thoroughly curetted. The overhanging edges of mucous membrane are cut away so as to throw the interior of the cavity into continuity with that of the bladder. This objective is aided by firmly packing some gauze into the recess from which the stones

were removed. Owing to the accompanying inflammatory changes in the prostate and its surroundings it is impossible in cases in which the lithiasis is well developed to enucleate the gland in the ordinary way.

**WHEN THERE IS RETENTION OF URINE**—When this is acute it calls for immediate relief and can frequently be dealt with successfully by the passage of a small catheter. The instrument should then be left *in situ* so that the surgeon will have ample time to consider the best means of dealing with the stone. If a urethral instrument cannot be made to negotiate the obstruction the operator will have to consider whether the crisis should be met by opening the bladder or the urethra. External urethrotomy should be carried out for choice as by this means the stone is removed at the same time that the retention is relieved.

In all cases where renal damage is present from back pressure it is important to give a guarded prognosis concerning the immediate results of any kind of interference for the relief of retention of urine. This is especially necessary if surgical intervention has resulted in the sudden escape of a large quantity of urine. An important advantage of the relief by urethral instrumentation is that it becomes an easy matter to provide for a gradual emptying of the bladder. This indication can also be met however by suprapubic operation by using one of the suprapubic puncture apparatus already described (fig 276).

### URETHRAL CALCULUS IN THE FEMALE

**Ætiology**—Because the female urethra is short and dilates readily it rarely is the seat of a calculus. A stone may develop in the female urethra on a foreign body.

**Pathological anatomy**—There are two groups of stones according to whether they are found in the urethra itself or in pockets which open into the floor of the urethra. Multiple stones may arise in this way. These are generally about the size of Indian corn rounded and tend to be faceted. An individual stone may reach the size of an olive. The orifices of these pouches into the urethra may be large or small. As these stones develop in size so they tend to cause urethral obstruction and dilatation. In chemical composition they have the general characters of urinary calculi. A foreign body in the urethra usually projects into the bladder as well and a stone which forms upon it begins in this situation.

**Symptoms, signs and diagnosis**—In the female a stone may be impacted in the urethra for several days but is usually expelled in due course. The female urethra can rid itself of particularly large stones. A sudden pain and some degree of difficulty with micturition which may soon be relieved as the stone escapes are the features of most cases.

Calculi which arise locally or small exogenous stones which become impacted slowly give rise to increasing disturbances of micturition with some urethral discharge which tends to become blood stained but there are no symptoms which are characteristic and the true cause will only be discovered by a thorough investigation. On passing an instrument if either grating or obstruction by a hard object occurs the diagnosis is made but the instrument may quite easily pass by a stone in a recess or pouch without detecting it. On the other hand by keeping the beak of the instrument directed towards the floor it may be made to enter a pouch and to discover a stone. Vaginal examination may reveal an area of thickening in relation to the anterior vaginal wall and the urethra in which the stone may be felt or observed. An X ray may

be a valuable aid at this stage. Incontinence of urine is likely to be the chief feature where the stone lies partly in the bladder and partly in the urethra.

**Treatment**—Where it is a question of a stone arrested behind a constricted external urinary meatus simple dilatation will suffice to allow the stone to be removed. In other cases forceps can be inserted through the meatus so as to grasp the stone firmly and gently ease it forward, while a finger pressing through the anterior vaginal wall forces the stone forward. Removal under vision through a urethroscope may be necessary in certain cases. Pushing the stone back into the bladder, where it is crushed with a lithotrite is the best means in some cases. External urethrotomy is a procedure which is essential in exceptional circumstances.

In the presence of stone in a diverticulum the latter must be opened through the anterior vaginal wall, and its mucous lining removed by dissection after the stone has been extirpated. It may be convenient to dissect out the sac while the stone is still *in situ*.

## PREPUTIAL CALCULI

**Ætiology**—The condition is a rare one, and the most striking cases reported have been among those peoples who are to some extent out of touch with the amenities of modern civilization. It occurs from the earliest to the latest years in life, but the majority of sufferers are patients of advanced age. The essential predisposing cause is a marked condition of phimosis. This aids the formation of calculus in the preputial sac by allowing the accumulation of smegma and urinary salts. The first result is inevitable where the retraction of the foreskin is impossible, while the second is only noted with extreme degrees of phimosis.

In the latter cases the preputial orifice is so small that the act of micturition invariably results in the accumulation of urine in the preputial sac. This may occur to such an extent that the sac is distended like a rubber ball from which a fine, irregular spray of urine finds its way under tension.

In civilized communities extreme congenital phimosis is seldom allowed to persist. The narrowing is not, however, always congenital. Late in life chronic inflammation may involve the foreskin, as a result of a mild degree of phimosis, and add further constriction to an already meagre orifice.

**Pathological anatomy**—There are three varieties of preputial calculi: those resulting from inspissated smegma, others from a mixture of smegma and urinary salts, and, lastly, those which consist of urinary salts entirely. The first are multiple greyish, semi-solid bodies generally packed closely together in the coronal sulcus, to which they are often adherent to the extent of causing a little bleeding when removed by gauze dissection. The second variety usually consist of a nucleus of smegma on which urinary salts have been deposited. They depend on the regular accumulation of urine under the prepuce. The third variety do not originate in the preputial cavity at all, but are urinary calculi proper which have formed in some part of the tract above and escaped from the external urinary meatus, but have been too large to pass through the orifice of the prepuce. The odd cases which have fallen within my own experience have been in one of the first two groups. Whether or not a preputial calculus consisting of urinary salts is formed *in situ*, its chemical composition is likely to consist of any of the salts commonly found in urinary concretions.

Triple phosphate (ammonium-magnesium phosphate) forms a large proportion of stones which originate *in situ* on account of the septic condition

of the sac They may be single or multiple Sometimes there are as many as 100 or more One case has recently been described in which 208 small calculi were present In size such calculi vary from small seed like bodies up to a single mass of 2 or 3 in in diameter in extreme and exceptional cases

The presence of a stone causes ulceration and a continuous purulent discharge The inflammation seems to attack the prepuce much more than the glans which is often found barely affected while advanced changes are present in the foreskin Ulceration may even give rise to a fistula so that if there is any obstruction to the outlet by the stone the urine may entirely escape by the new channel The inguinal glands become chronically enlarged

The glans sometimes becomes diminutive in size and infantile in type as a result of the pressure of the stone and the urine during micturition Carcinoma of the glans or prepuce is a sequel to the presence of stone which is not unknown In old standing cases the urinary passages behind the obstruction become dilated and infected

**Symptoms and signs**—In cases where the phimosis is extreme the two outstanding features associated with micturition are a ballooning of the preputial sac and a delay in completing the act the patient often finding it helpful to manipulate the stones so as to improve the flow In one case that has been reported the preputial sac would distend with micturition to the size of a large lemon

**Treatment**—The treatment should consist in first opening the sac widely by making a dorsal incision from the orifice backwards clearing out the stones and then performing circumcision if the foreskin is very hypertrophied If there is much associated sepsis it is better to leave the circumcision until the inflammation has subsided Alternatively if the dorsal slit is carried as far as the level of the coronal sulcus and the prepuce is not greatly hypertrophied further circumcision is as a rule not required

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## CHAPTER LXXXIII

### THE MANAGEMENT OF GLYCOSURIA IN GENITO-URINARY SURGERY

#### CAUSE OF THE GLYCOSURIA

WHEN a patient who requires surgical treatment is found to have a substance in the urine which reduces Fehling's or Benedict's reagent it is essential to decide by appropriate tests that the reducing substance is in fact glucose. Although the majority of patients with glycosuria suffer from diabetes mellitus the possibility of non diabetic glycosuria being present must be remembered. Over activity of the anterior pituitary, thyroid or adrenal glands may lead to hyperglycæmia and glycosuria. The existence of such conditions can usually be diagnosed by the clinical features of acromegaly, Cushing's syndrome, thyrotoxicosis etc. The treatment of the resulting glycosuria in these states consists primarily of measures aimed at reducing the activity of the gland concerned. The hyperglycæmia of these endocrine disorders is usually moderate in degree and in general calls for no special pre operative treatment since the danger of ketosis is negligible. Occasionally they are associated with a true diabetes of a very severe type which must be treated on the lines described hereafter.

In contrast with the glycosuria due to endocrine dyscrasias glycosuria may result from a lowered renal threshold or from a delay in the mechanism for storage of carbohydrate in the liver. The diagnosis of these two conditions can only be made from symptomless mild diabetes mellitus by means of a glucose tolerance test. This test should invariably be carried out when doubt exists in order to obviate the submission of the patient to unnecessary dietetic restrictions and to prevent the production of hypoglycæmic attacks should insulin be unnecessarily employed.

This chapter will be devoted to the management of a patient suffering from proved diabetes mellitus who requires operative treatment.

#### TREATMENT OF SURGICAL DIABETICS

The general principles underlying the treatment of surgical diabetics are in the main the same no matter the nature of the disease present or the organ affected. It is proposed therefore to discuss such general principles first and thereafter to refer to some points of special interest to the genito urinary surgeon.

IMPORTANCE OF MEDICAL TREATMENT.—The modern treatment of surgical diabetes with properly controlled diet and insulin has largely reduced the liability to post operative death from acidosis, dehydration and circulatory failure. Nevertheless even in the most skilled hands major surgical operations on diabetics still entail considerable risk to life which bears a correlation to the skill displayed in the control of the disease. Joslin (1940a) says that the mortality in cases operated on in clinics with special experience of diabetic treatment is about 7 per cent as compared to 20 per cent when operation is

performed under less favourable conditions To obtain the best results the writer submits the following recommendations

*Place of operation*—Since the surgeon cannot be expected to have an adequate knowledge and experience of modern methods of treatment of diabetes with insulin and diet he should not assume responsibility for the medical aspects of the case but should obtain the co-operation and help of an experienced physician The operation should be performed only in a nursing home or an institution where proper facilities are available for intravenous therapy and where instructions regarding diet and insulin can be safely entrusted to a nurse experienced in this particular field When these conditions are fulfilled there exists no contraindication to operation on diabetics, and the decision whether to operate or not should be determined entirely by surgical considerations The successful removal of sepsis by operation and the prevention of its arising are factors of great importance in improving or arresting the diabetic state

*Choice of anæsthetic*—The choice of anæsthetics is of paramount importance because of the danger of ketosis which is liable to develop from the consequent hepatic damage and from dehydration resulting from post-operative vomiting Chloroform should never be used and ether is also best avoided Local anæsthesia should be employed whenever possible or if fuller relaxation is required, spinal anæsthesia, preceded if necessary by narcosis with nitrous oxide and oxygen If general anæsthesia is essential, reliance should be placed on nitrous oxide and oxygen and the period of anæsthesia should be as short as possible Morphine increases anoxia and if given at all should be used only in small doses such as  $\frac{1}{2}$  gr

*Control of diabetes prior to operation*—Unless immediate operation is essential to save life every attempt should be made to control the diabetes prior to operation and thus bring the patient to surgical treatment free of acidosis and dehydration and with a blood sugar as near normal as possible

*Consideration of the emergency of the operation*—The management of a case of surgical diabetes is essentially based on two considerations First, whether the case constitutes a surgical emergency requiring immediate operation or whether operation can be delayed until the diabetes is controlled And second the assessment of the severity of the diabetes as judged by the clinical state of the patient and the examination of the urine for sugar and ketone bodies and if possible, the blood for hyperglycæmia It should be remembered that a positive result with Gerhardt's (ferric chloride) test is of more serious significance than a positive Rothera's (sodium nitro prusside) test, since the former test is less delicate and when positive, indicates approaching coma

**DIET AND INSULIN REQUIREMENTS IN PRE OPERATIVE AND POST-OPERATIVE TREATMENT**—Since the diet and insulin requirements vary widely in individual cases and in the same case from time to time it is not possible or desirable to give a scheme of treatment suitable for all cases It is possible, however to lay down certain general principles

*Non emergency cases*—(1) If the operation is a relatively simple procedure which can be carried out under local or spinal anæsthesia, and if the diabetic state is of mild degree which can be controlled by diet alone it is usually unnecessary to give insulin prior to operation or to alter the diet except that for the twenty-four hours prior to operation the bulky green vegetables should be replaced by more concentrated carbohydrate foods and by glucose

(2) If the operation constitutes a major surgical procedure, and if the patient is suffering from diabetes of moderate or marked severity requiring

insulin, operation should be delayed if possible until the hyperglycæmia and the ketosis, if present, are brought under control by diet combined with insulin. The diet should be light and easily digested, and should contain at least 150 gm of carbohydrate daily and be relatively low in fat. A suitable diet, as recommended by Davidson and Anderson (1942) is appended (I). The amount of insulin to be given at each injection can be assessed approximately by the result of Benedict's test for sugar in the urine. If the colour is deep red, give 30 to 40 units of soluble insulin, if deep yellow 20 to 30 units, if yellow green, 10 to 20 units. The higher figure should be used in each case if ketone bodies are present as well as sugar. Although a combination of zinc protamine insulin and soluble insulin can be used for pre-operative and post-operative purposes, the more rapidly acting soluble insulin is to be preferred. Plenty of fluid should be taken in the days preceding operation to counteract the danger of post-operative dehydration. On the day of operation three hours before removal to the surgical theatre the patient should take 30 to 40 gm of glucose in a glass of water flavoured with orange or lemon juice and an injection of 15 to 30 units of soluble insulin should be given, the dose depending on the assessment of the severity of the diabetic state. Assuming that the operation takes place during the morning, in the late afternoon or evening of the day of operation the patient should be placed on the type of diet recommended by Lawrence for the treatment of coma. Such a diet consists of a variety of fluid feeds each containing approximately 25 gm of carbohydrate given every three to four hours. Examples of such feeds are as follows —

- (a) Orangeade Orange juice  $3\frac{1}{2}$  oz (100 c c) Glucose  $\frac{1}{2}$  oz (15 gm)  
Water flavoured with lemon juice  
25 gm carbohydrate
- (b) Thin porridge from  $\frac{3}{4}$  oz dry cereal (oatflour, cream of wheat, barley flour)  
Hot milk, 6 oz  
24 gm carbohydrate
- (c) Bread,  $\frac{3}{4}$  oz  
Milk, 6 oz  
Sugar, 5 gm (1 teaspoonful)  
25 gm carbohydrate
- (d) Benger's food,  $\frac{1}{2}$  oz (dry weight)  
Milk, 6 oz  
Sugar 5 gm (1 teaspoonful)  
25 gm carbohydrate

Insulin is given every six hours, that is before every second feed, the dose being regulated by urinary analysis as already described. If post-operative retention occurs, specimens must be obtained BY CATHETER. If, for any technical reason connected with the nature of the operation or because of post-operative vomiting, the patient is unable to take food or fluid by mouth, recourse must be had temporarily to INTRAVENOUS THERAPY. A cannula should be tied into a vein and glucose and water must be given as a continuous drip in the form of 5 per cent glucose saline. Not less than 3 litres or more than 5 litres should be given in the twenty four hours. Insulin should be injected every four to six hours in doses regulated by the method of urine analysis described above.

For twenty four to forty eight hours after operation the patient should be placed on a fluid diet containing approximately 1,000 calories and 115

gm of carbohydrate. An example of such a diet is appended (II) (Dunlop Davidson and McNee 1946). The number of injections of insulin can be reduced to three daily. Thereafter the patient is usually well enough to be transferred to a light convalescent diet containing 150 gm of carbohydrate as appended and insulin can be given twice daily. A gradual return can be made to a permanent maintenance diet the amount of insulin being adjusted as necessary.

*Emergency cases*—If a major emergency arises requiring immediate operation the patient should receive three hours before operation 30 gm of glucose by mouth and 10 to 20 units of soluble insulin if he is a known diabetic who has been controlled by diet alone whereas if he has been an insulin treated case he should receive 40 gm of glucose and a dose of insulin which represents his normal morning insulin dose plus 10 additional units.

If the diabetes is discovered for the first time immediately prior to an emergency operation 30 to 50 gm of glucose and 20 to 40 units of insulin should be given three hours prior to operation the quantities being regulated by the results of urinary analysis and the clinical state of the patient.

The subsequent post operative treatment should be on the lines described above.

### SOME FEATURES OF SPECIAL IMPORTANCE IN GENITO URINARY SURGERY

**GENITO URINARY COMPLICATIONS OF DIABETES**—*Incidence*—The genito urinary complications of diabetes requiring operation are apparently uncommon since Joslin (1940B) reports an incidence of only 123 operations on the genito urinary tract out of 2 941 operations performed on diabetics in the New England Deaconess Hospital between 1923 and 1939.

*Tuberculosis*—Tuberculosis of the genito urinary tract in diabetics appears to be extremely rare as Joslin reports no case in the statistics of the Deaconess Hospital.

*Urinary infections*—Those requiring medical treatment are however particularly liable to occur and have an inhibiting effect on the efficacy of insulin treatment and cause a deterioration in the diabetic state. The surgical removal of septic foci in the urinary tract and the restoration of free drainage by removal of obstructions to the output of urine are factors of considerable importance in the prevention and treatment of genito urinary infections.

*Urinary antiseptics*—If urinary antiseptics are to be employed in diabetes mellitus on general principles it would appear wise to avoid those of which the efficacy depends on the production of an acidosis i.e. the ketogenic diet or mandelic acid and ammonium chloride.

*Control of diabetes before operation*—In the majority of cases of genito urinary disease requiring operation the operation can be delayed for a few days to enable the diabetic state to be got under control. This is particularly the case in vesical obstructive lesions where preliminary suprapubic drainage is first undertaken. The great improvement in the patient's health which may follow this procedure may convert a severe diabetes into one of moderate severity or relative mildness.

*Renal failure complication*—When the patient is suffering from renal failure as well as diabetes mellitus the possibility of acidosis of two different types occurring simultaneously must be remembered. The giving of alkalis in large doses every two to four hours in such cases in addition to the treatment outlined above for the control of ketosis would appear to be based on sound principles.

**Urinary obstruction**—Where obstruction to the urinary output is present the procuring of specimens of urine for analysis of sugar and acetone may present a serious problem. Moreover if the bladder can only be partially emptied it becomes extremely difficult to correlate the urinary findings in relation to the coincident hyperglycæmia. In this case the regulation of insulin dosage according to the results of Benedict's test should only be attempted if the sample of urine is obtained BY CATHETER every four to six hours and the surgeon is satisfied that on each occasion the bladder is completely emptied. If these requirements cannot be fulfilled it is essential to regulate the treatment by blood sugar estimations made on samples of blood withdrawn on at least two or three occasions in the twenty four hours prior to and subsequent to operation.

When anuria results from impaction of a calculus or from any other cause the dosage of insulin must be based on blood sugar estimations until urinary secretion is re established.

## APPENDIX I\*

\* (From Davidson L. S. P. and Anderson I. A. (1947) Textbook of Dietetics London p. 72.)

## LIGHT DIABETIC DIET

Approximately 1500 calories with 150 gm. carbohydrate

## Soluble insulin

## Breakfast—

	Prot	Fat	Cho	Calories
Strained porridge 3 tablespoons or equivalent	18.7	13.8	40.0	359.0
Milk (6 oz.) for tea and porridge				
White crustless bread toasted 1 oz. (weigh before toasting)				
1 egg scrambled or poached				

## Forenoon—

Cup of Marmite	2.0	0.5	10.0	52.5
Two cream crackers				

## Dinner—

Chicken or rabbit 2½ oz.	22.9	9.3	23.7	278.1
Sieved carrot 2 oz.				
Crusted white bread ½ oz.				
Stewed apple 3½ oz. or equivalent				
Serve with milk 2½ oz.				

## Soluble insulin

## Tea—

White fish or sweetbread, or cold tongue 3 oz.	29.0	5.6	39.5	374.4
White crustless bread 2 oz.				
Butter (or vitaminized margarine) from ration				
Milk for tea and fish 5 oz.				

## Supper—

Benger's or fine cereal ½ oz.	6.5	6.5	6.0	24.0
Milk 6½ oz.			9.7	123.3

## Bedtime—

Orange juice 3½ oz.			10.0	40.0
Glucose ½ oz.			10.0	40.0

## Daily Rations—

Total milk 20 oz. (1 pint) included above				
Total butter (or vitaminized margarine) 1½ oz.		31.2		280.8

## TOTAL

79.0	66.9	150.9	1522.1
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## APPENDIX II \*

\* From Dunlop D M Davison L S P and McVee J W (1916) Textbook of Medical Treatment 4th ed Edn p 323

## FLUID DIET FOR DAY FOLLOWING OPERATION

	Carb	Prot	Fat
<i>Early Morning—</i>			
Cup of tea milk 2 tablespoonfuls	15	10	10
<i>7.30 A.M.—</i>			
Soluble insulin			
<i>Breakfast 8 A.M.—</i>			
Strained porridge (4 tablespoonfuls dry meal)	20.0	5.0	2.0
Hot milk 3 oz	7.5	5.0	6.0
<i>10 A.M.—</i>			
Milk hot or cold 3 oz	7.5	5.0	6.0
<i>12.30 P.M.—</i>			
Soluble insulin			
<i>Dinner 1 P.M.—</i>			
Milk 5 oz			
Milk 4 oz	6.0	4.0	5.0
Sliced carrot 1½ oz	2.7	0.0	
Or Tomato juice 3 oz			
Stock or Bovril as required			
Milk 1½ oz			
Dry cereal ½ oz	8.0	1.0	
Milk 6 oz	0.0	0.0	7.0
Milk to serve 2 oz	3.0	2.0	2.4
<i>Tea 4 P.M.—</i>			
Tea with milk 1 oz	1.5	1.0	1.0
One tablespoonful or ½ oz of thin bread with butter to cover	7.0	0.0	1.0
<i>6.30 P.M.—</i>			
Soluble insulin			
<i>Supper 7 P.M.—</i>			
Black Raspberry Food ½ oz	19.0	1.5	
Milk 6½ oz	10.0	6.6	8.0
Sugar 1 teaspoonful	5.0		
<i>9 P.M.—</i>			
† Orange juice 3 oz	9.0		
Sugar 1 teaspoonful	5.0		
<b>TOTAL</b>	<b>117.0</b>	<b>39.0</b>	<b>39.0</b>
<b>Total Calories 667</b>			
† When orange juice is not available substitute			
Milk 6 oz	0	6	7
Hot milk 1 tablespoonful	7	1.5	0.7

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